

Gernot Hoffmann
The Digital Munsell

Glossy version
Colors by Lab numbers
Illuminant D50

Out-of-gamut distances
for sRGB and ISOCoated

Protected by Copyright
Public scientific application
requires permission
Commercial application
requires a contract

March 3 / 2022

Website
Load Browser
Click here
<http://docs-hoffmann.de>

Contents

1. Introduction	2
2. Planes of constant Munsell Hue	3 - 41
3. Planes of constant Munsell Value in CIELab	43- 44
4. References	45

Introduction

The Munsell color system was created by the artist A.H.Munsell in 1905 and then improved over the years by scientists (Munsell renotation 1943).

The colors are arranged so, that the perceptual difference between two neighbours is constant, concerning the hue (M. Hue or H in degrees), the lightness (M.Value V) and eventually the chroma (M.Chroma C). Good descriptions can be found in text books [1],[2], [3], [5] and in the publication [19].

Munsell samples are available as chips [29]. The perceptual balance requires viewing under light similar to illuminant C [6]. Such an illumination is hardly anywhere found outside laboratories.

This document *The Digital Munsell* is based on the appearance of glossy Munsell chips under illumination D50. Light booths for D50 are available, either with fluorescent tubes or with *Solux* tungsten halogen bulbs [26]. There was no attempt to simulate the original appearance under illuminant C .

The author is most grateful to *Roger Breton* for interesting discussions, for supplying CIELab reference data (originally from X-Rite's ColorMunki) and for measured data. Reference data for some colors were missing. The gaps could be filled by Roger's measured data (under D50) for the complete set. The lightness of the Neutrals in ColorMunki [30] was too large. The CIELab data were replaced by Roger's measured data. One totally wrong set 2.5B_6/10 was ignored.

Data sets from the Munsell Color Science Laboratory [18] cannot be used, because they are valid for illuminant C. There are two versions: the real Munsells and the extrapolated Munsells. Real Munsell chromas are not larger than 16, whereas extrapolated Munsells can have chromas almost double as large. This is important for understanding some illustrations in [19] and for the interpretation of data in [1].

This doc shows a subset of about 1600 real Munsell colors, as existing in chip sets. It can be printed by a PostScript printer. All colors patches are programmed by CIE-Lab numbers.

The printer should work in PostScript mode ,Archive Format' instead of ,Optimized for speed'. Otherwise some elements might get lost.

Some printers cannot reproduce CIELab correctly. In such a case the CIELab values in the PDF should be converted by Acrobat Professional into ProPhotoRGB, and the printer should use this wide gamut space as input space.

The Munsell nomenclature is interpreted for instance like this:

10R 5/8 means H=18°, V=5 and C=8.

The Munsell Hue is defined by a name. The table contains the assigned angle in degrees.

Planes of constant H are made for multiples of 9°. Planes of constant V are made for all available hues.

Values V reach here from 0 to 10, including the ideal absorber and the ideal diffuser.

Chroma C is usually shown by steps of 2 (2 steps C should be perceptually equivalent to 1 step V).

Available data with C=1 are ignored.

Each page for a plane of constant H contains in fact two hues:

H1 and H2 = H1+180°.

Each page has a partner page which contains CIELab values L*,a*,b* and gamma encoded values R,G,B for sRGB (written without apostroph) .

If a color is out-of-gamut for sRGB, then the estimated out-of-gamut distance is indicated bottom right in CIELab units.

If a color is out-of-gamut for the specified CMYK space, which is at present ISO-Coated_v2_eci.icc, then the estimated distance is indicated bottom left in each field.

The underlying algorithms are described in [24].

Planes of constant V in CIELab contain gamut boundaries for sRGB and for the CMYK space. The lightness L* was calculated as mean value of all colors in each diagram.

Used Hues by name and angle Step dH=9°

2.5R	351
5R	0
7.5R	9
10R	18

2.5YR	27
5YR	36
7.5YR	45
10YR	54

2.5Y	63
5Y	72
7.5Y	81
10Y	90

2.5GY	99
5GY	108
7.5GY	117
10GY	126

2.5G	135
5G	144
7.5G	153
10G	162

2.5BG	171
5BG	180
7.5BG	189
10BG	198

2.5B	207
5B	216
7.5B	225
10B	234

2.5PB	243
5PB	252
7.5PB	261
10PB	270

2.5P	279
5P	288
7.5P	297
10P	306

2.5RP	315
5RP	324
7.5RP	333
10RP	342

Used Neutrals Step dV=1

N=0, 1, . . . 9, 10
Added N=0 and N=10

Unused

1.25YR	22.5
3.75YR	31.5
6.25YR	40.5
8.75YR	49.5

1.25Y	58.5
3.75Y	67.5
6.25Y	76.5
8.75Y	85.5

1.25GY	94.5
3.75GY	103.5
6.25GY	112.5
8.75GY	121.5

1.25G	130.5
3.75G	139.5
6.25G	148.5
8.75G	157.5

1.25PB	238.5
3.75PB	247.5
6.25PB	256.5
8.75PB	265.5

1.25RP	310.5
3.75RP	319.5
6.25RP	328.5
8.75RP	337.5

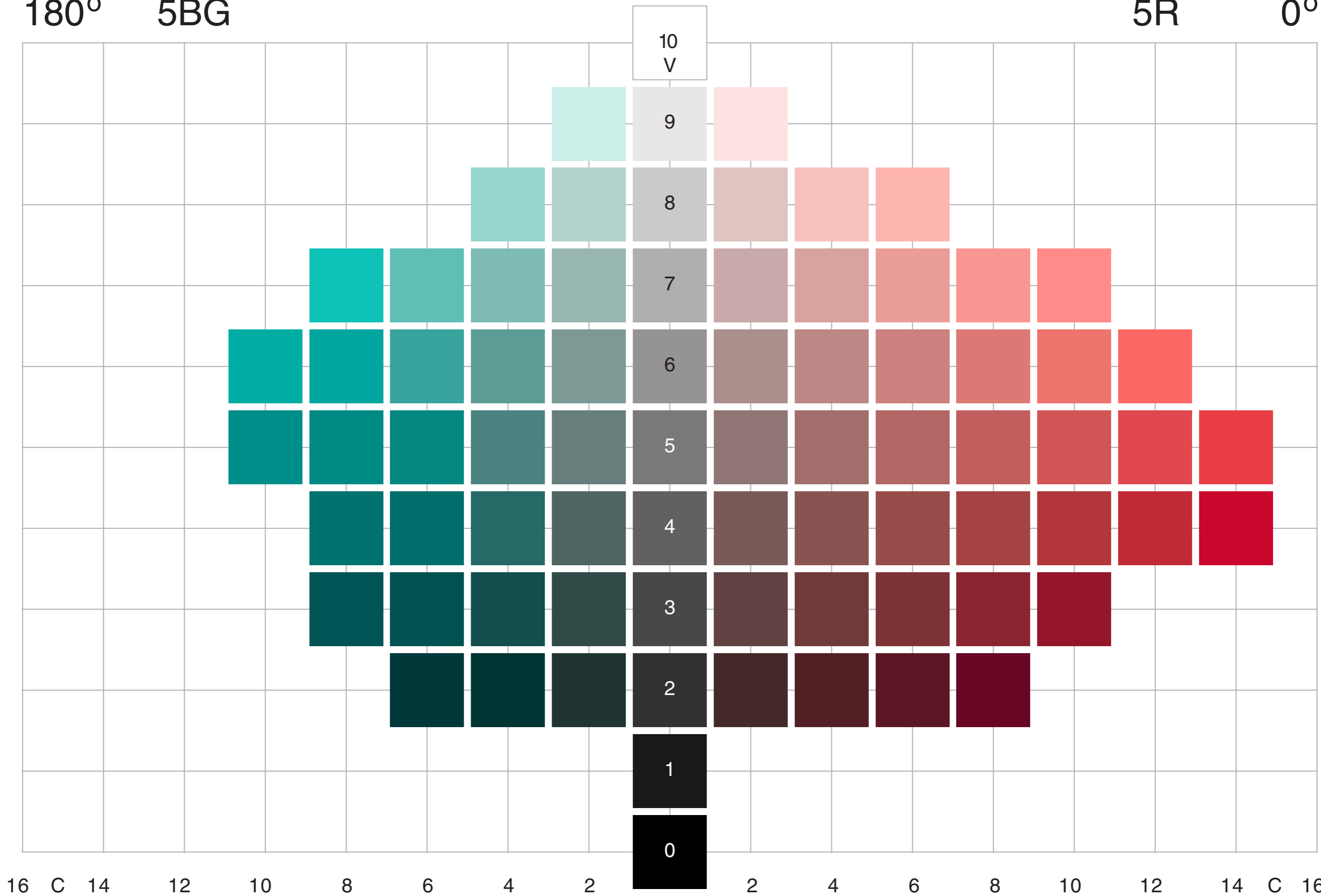
1.25R	346.5
3.75R	355.5
6.25R	4.5
8.75R	13.5

Patched by measured data

10YR	5/2
10YR	5/4
10B	2/4
7.5Y	8/10
5P	5/10

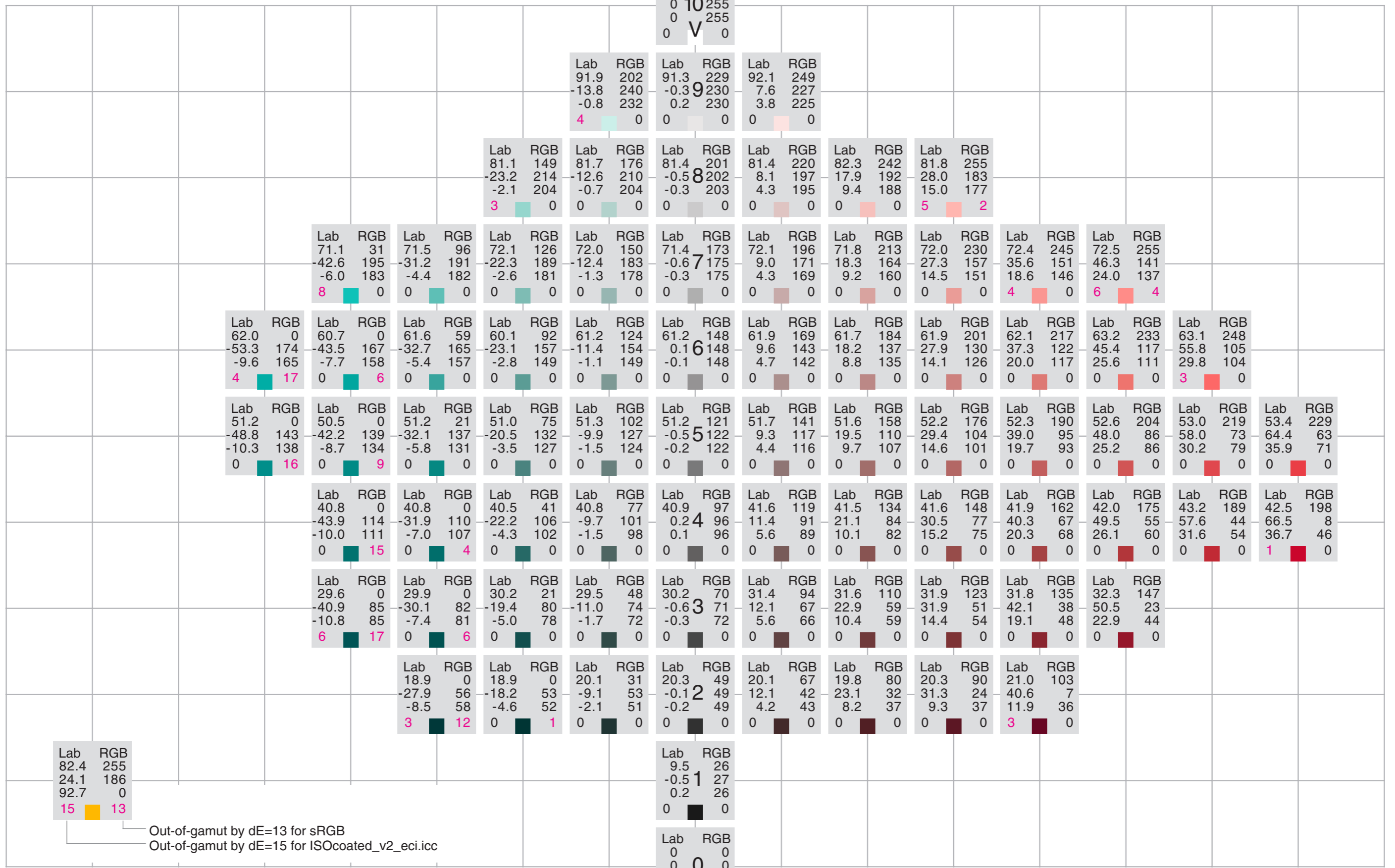
180° 5BG

5R 0°



180° 5BG

5R 0°

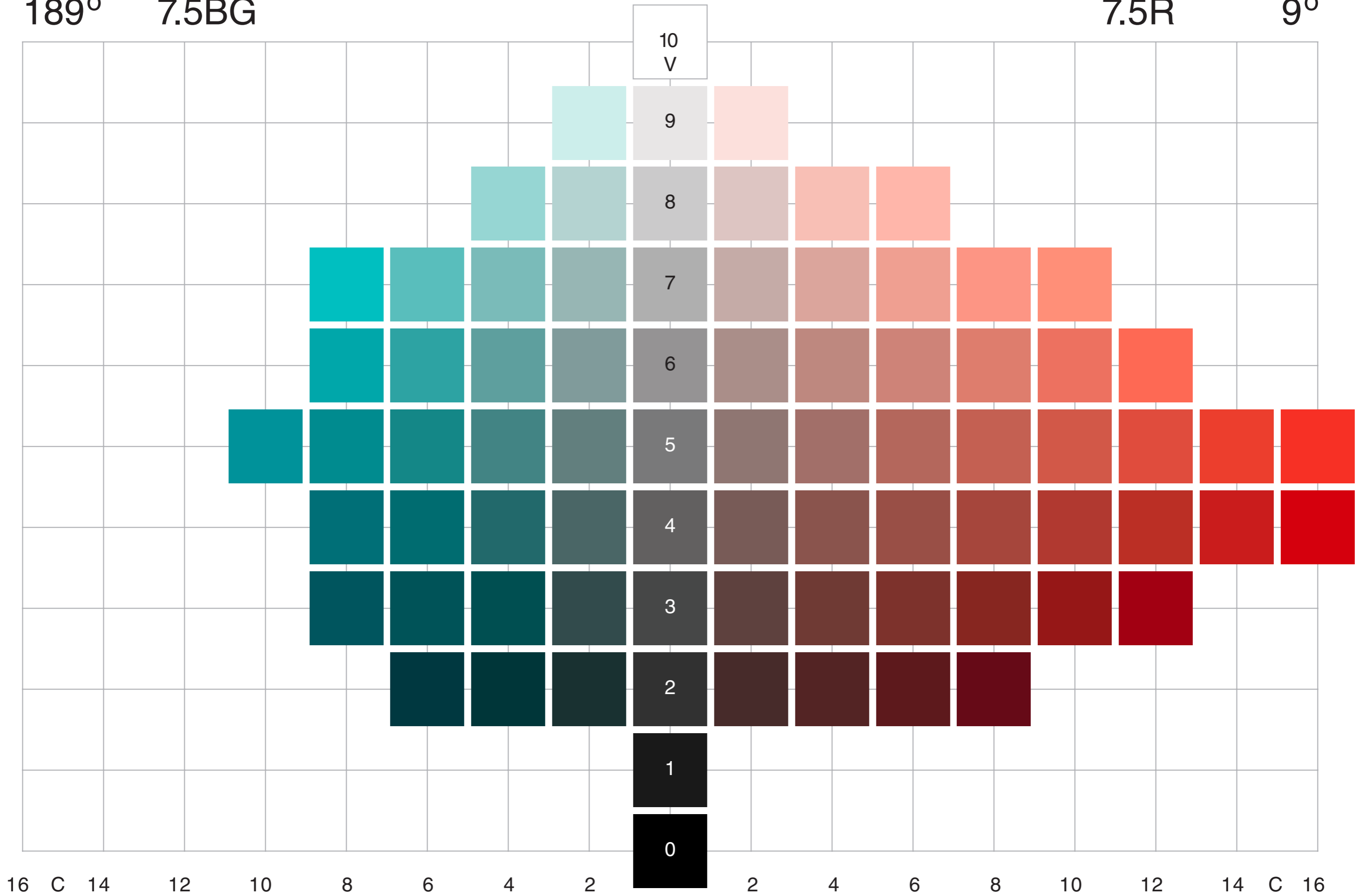


Out-of-gamut by dE=13 for sRGB
 Out-of-gamut by dE=15 for ISOcoated_v2_eci.icc

16 C 14 12 10 8 6 4 2 2 4 6 8 10 12 14 C 16

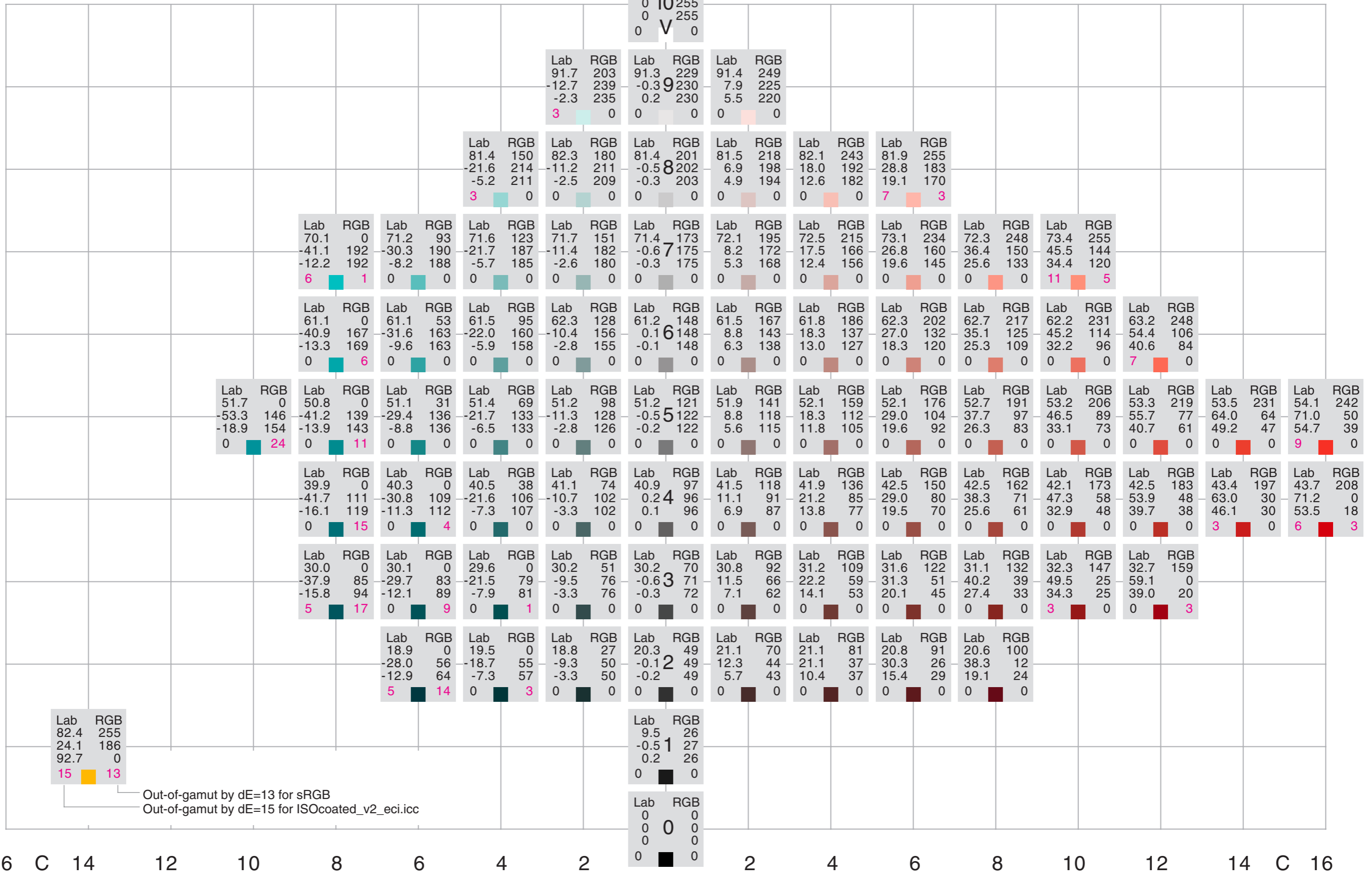
189° 7.5BG

7.5R 9°



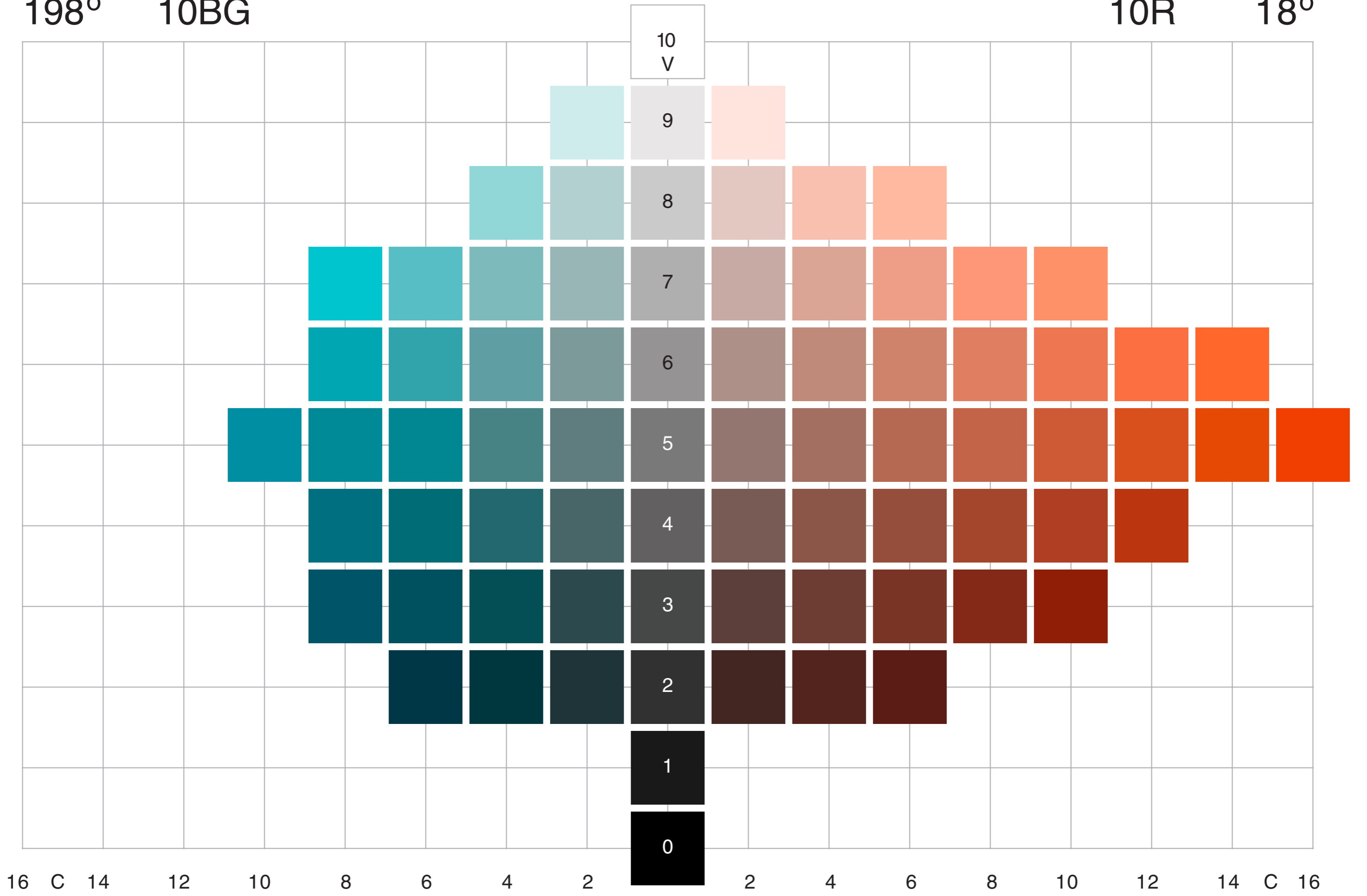
189° 7.5BG

7.5R 9°



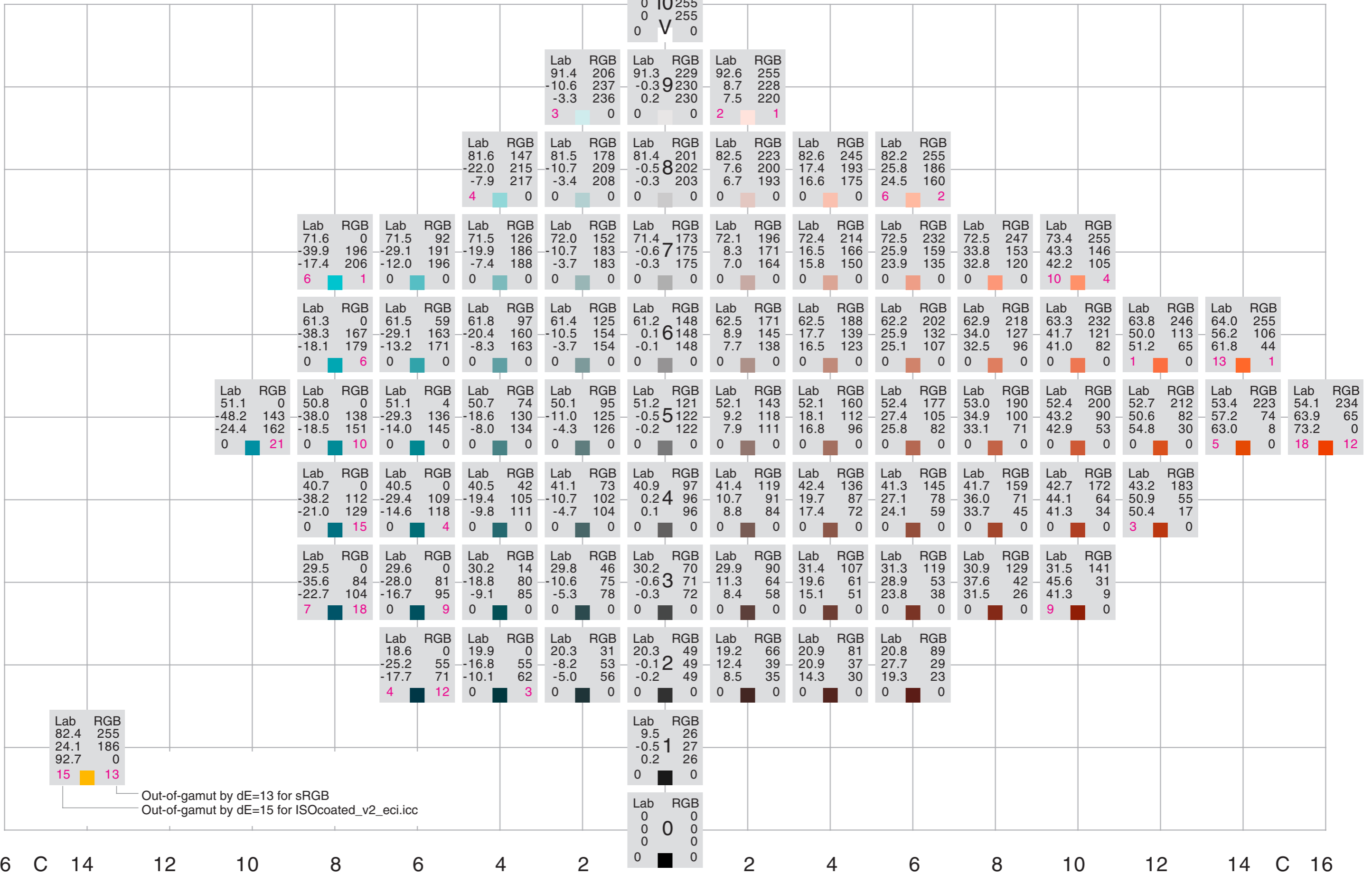
198° 10BG

10R 18°



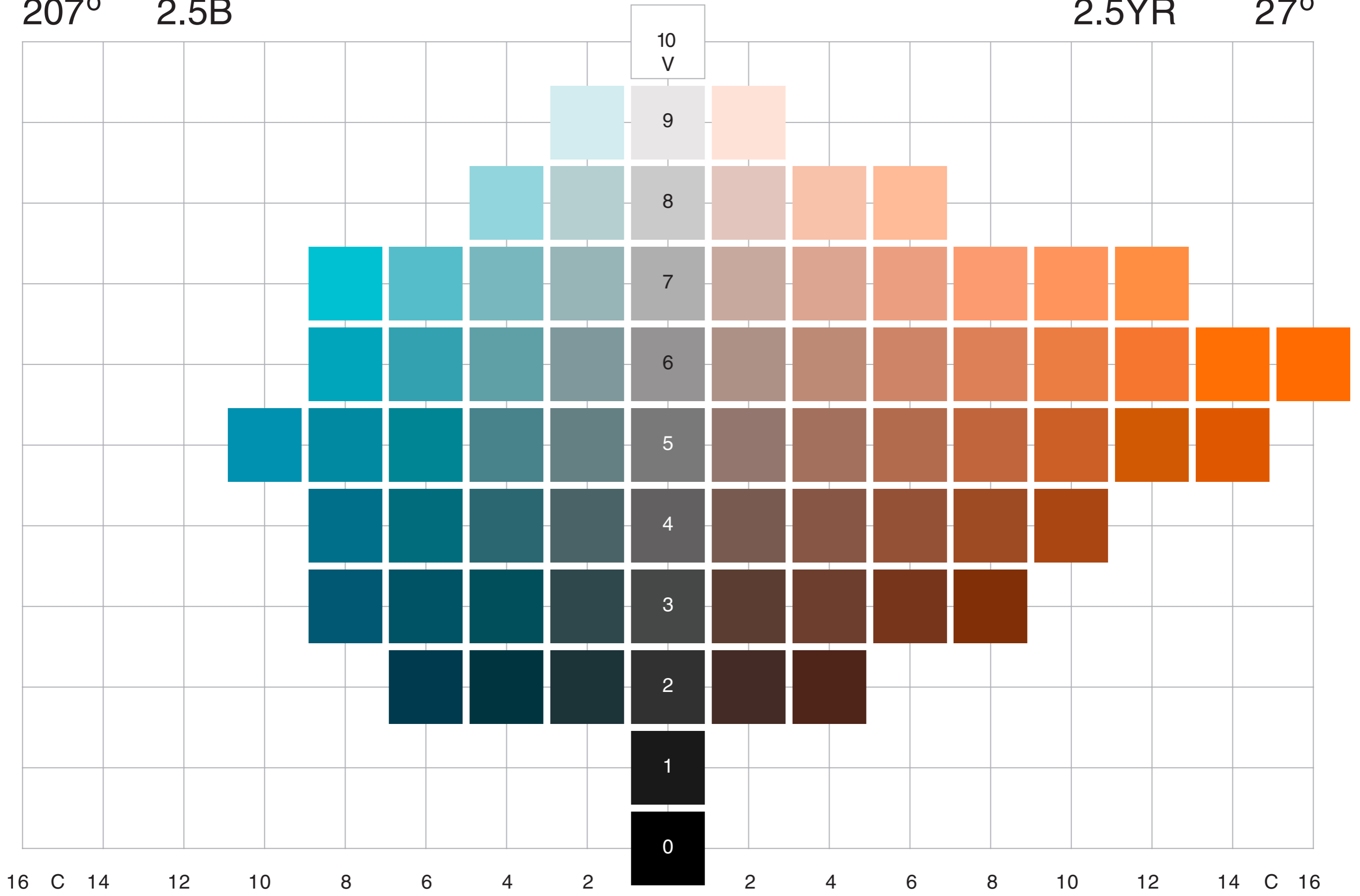
198° 10BG

10R 18°



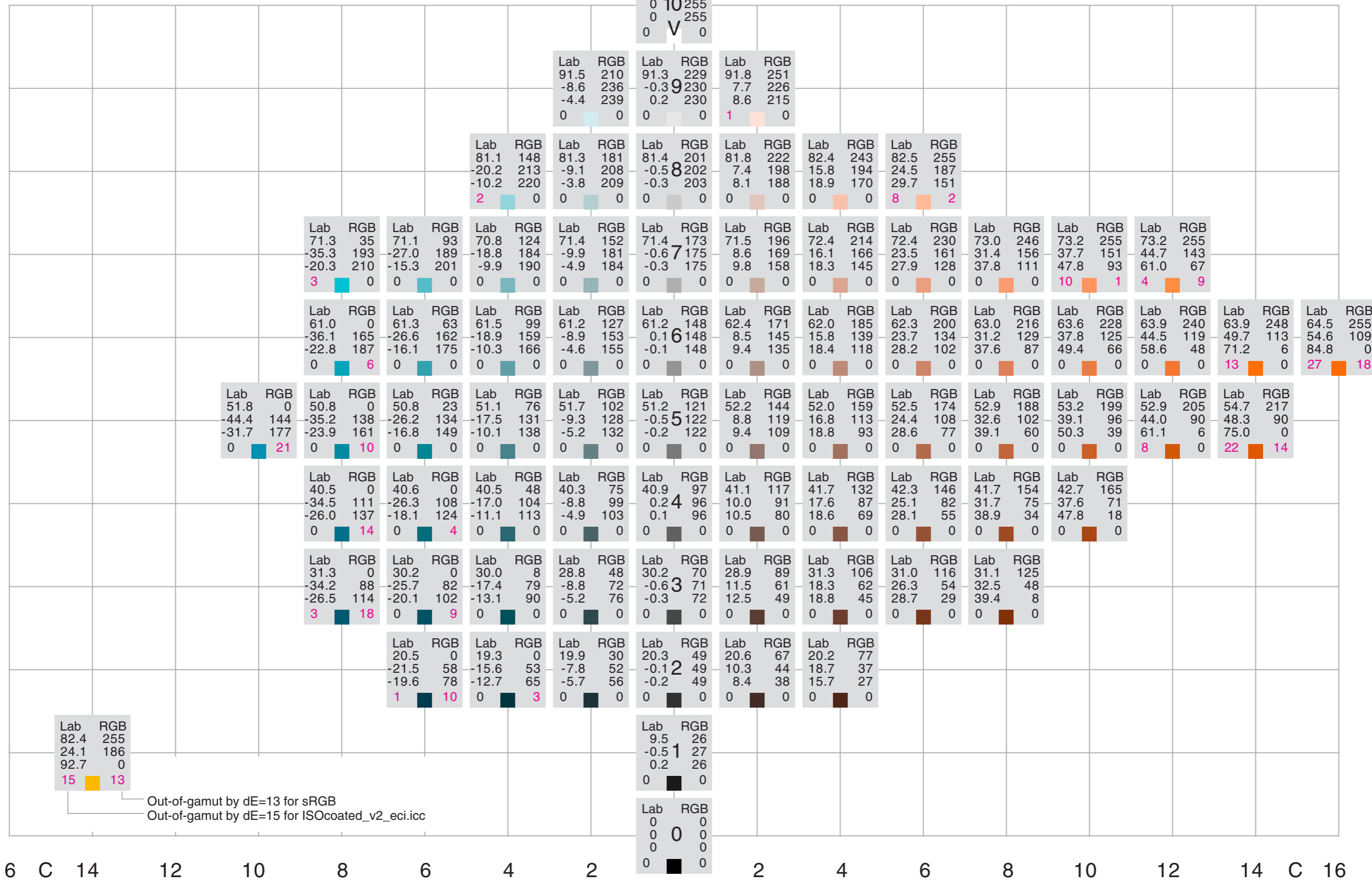
207° 2.5B

2.5YR 27°



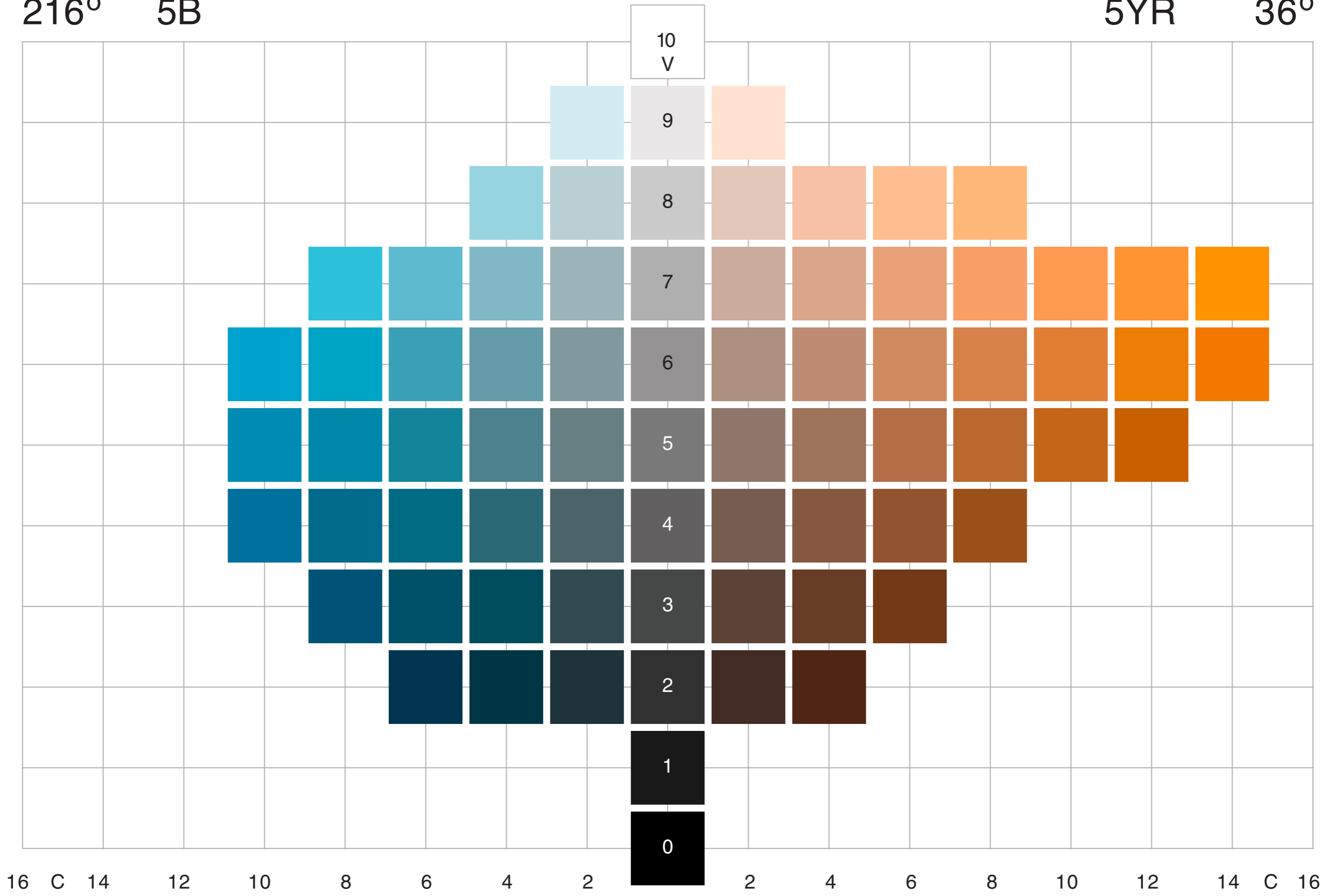
207° 2.5B

2.5YR 27°



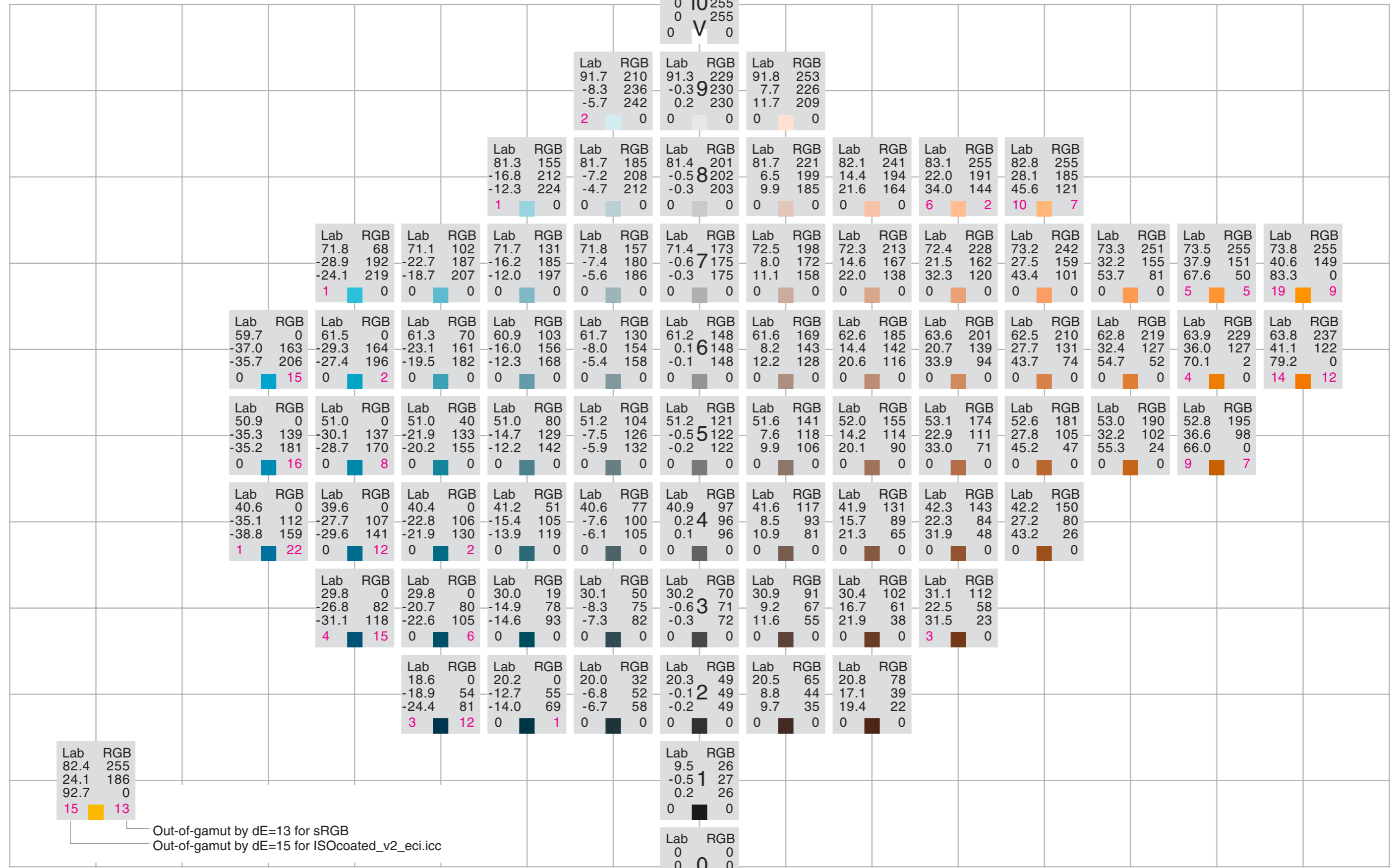
216° 5B

5YR 36°



216° 5B

5YR 36°

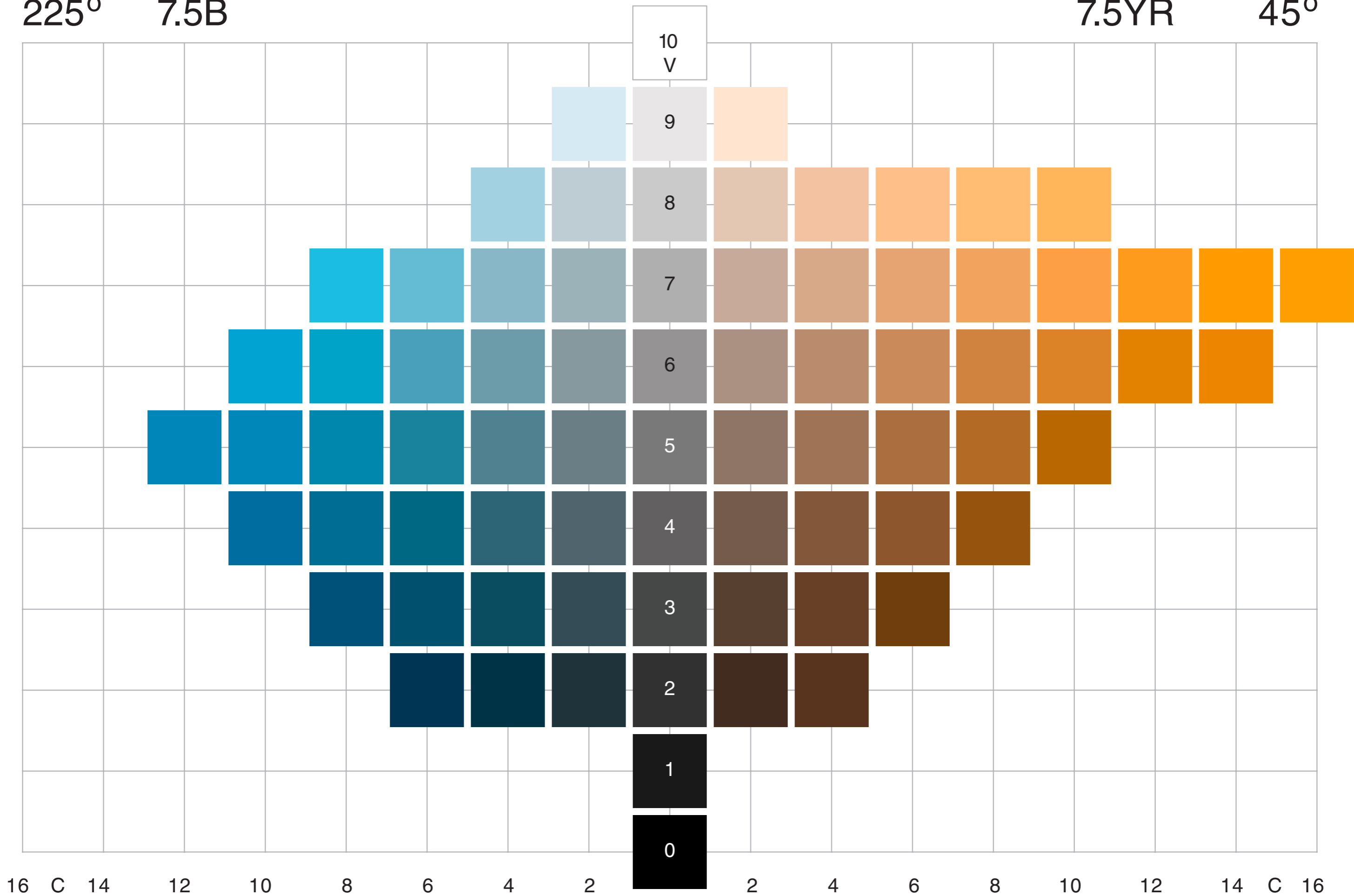


Out-of-gamut by dE=13 for sRGB
 Out-of-gamut by dE=15 for ISOcoated_v2_eci.icc

16 C 14 12 10 8 6 4 2 2 4 6 8 10 12 14 C 16

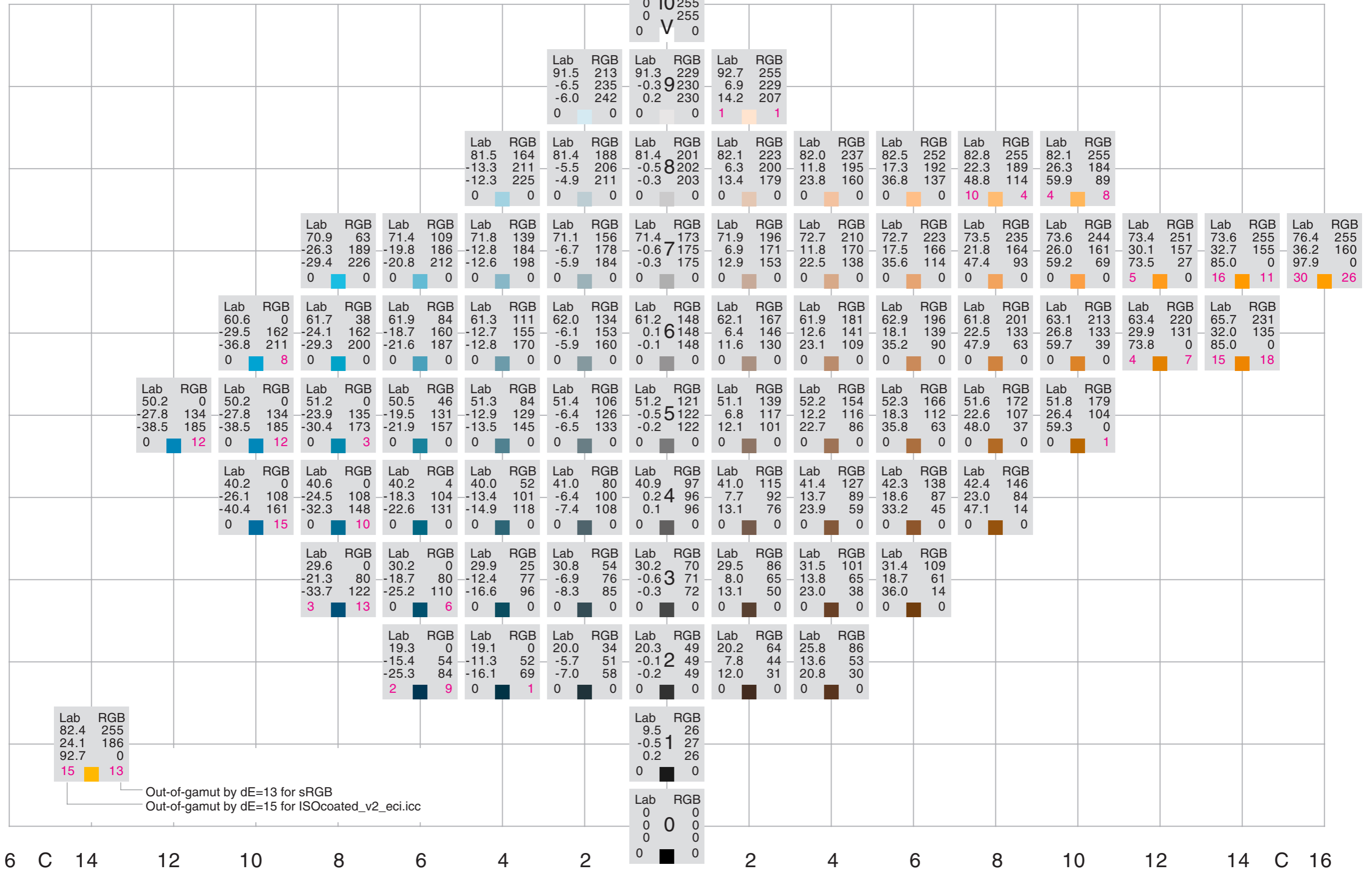
225° 7.5B

7.5YR 45°



225° 7.5B

7.5YR 45°

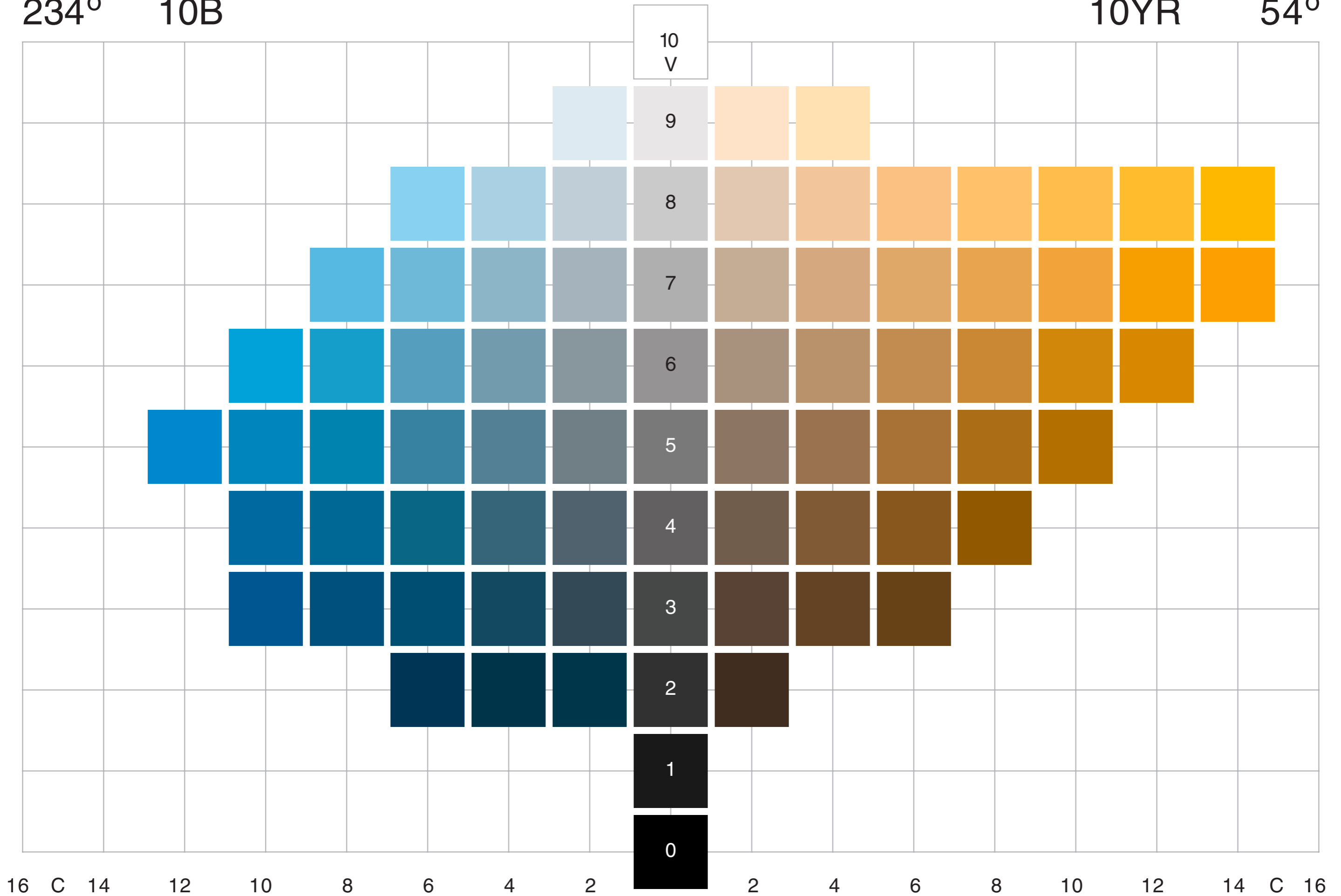


234°

10B

10YR

54°

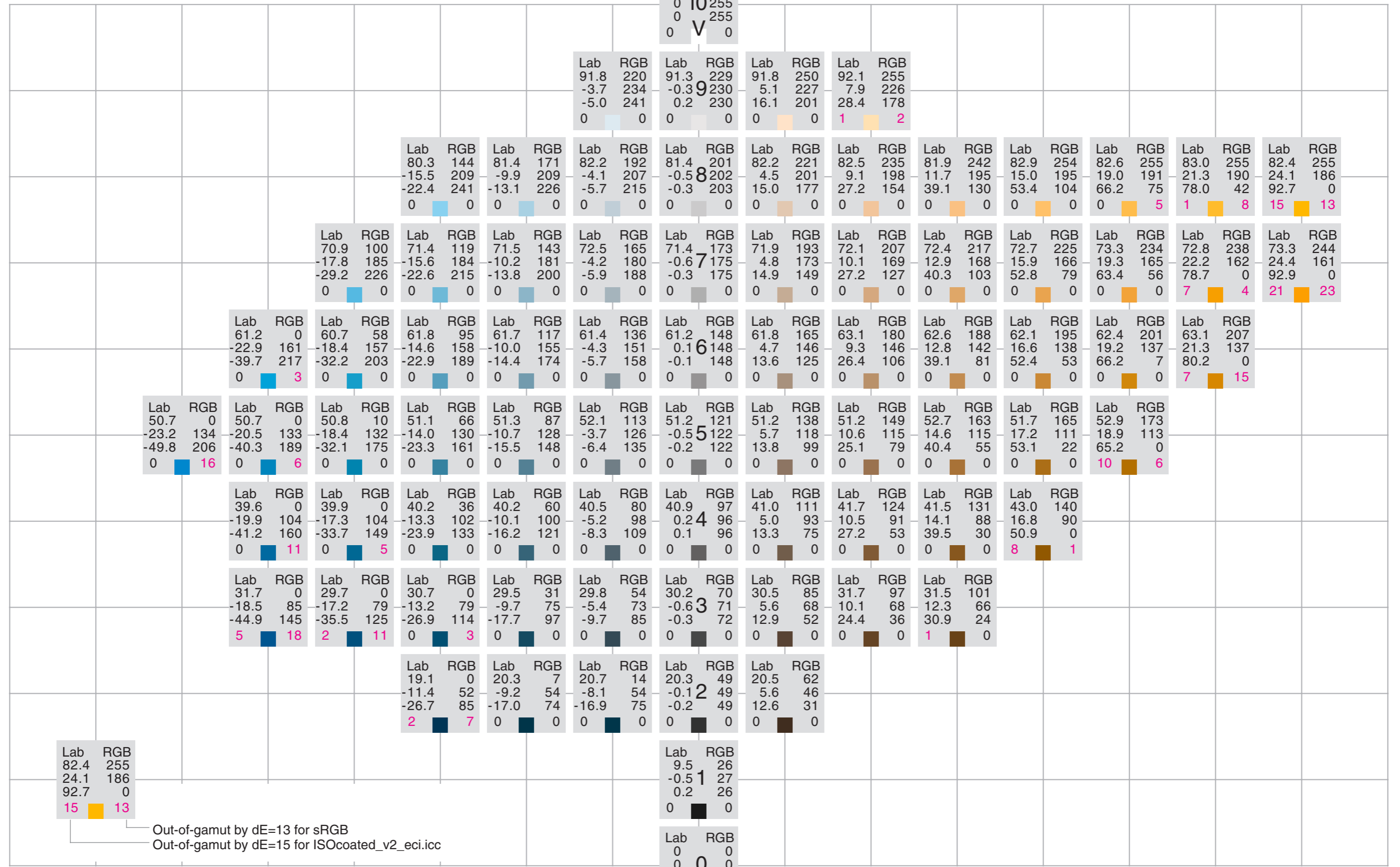


234°

10B

10YR

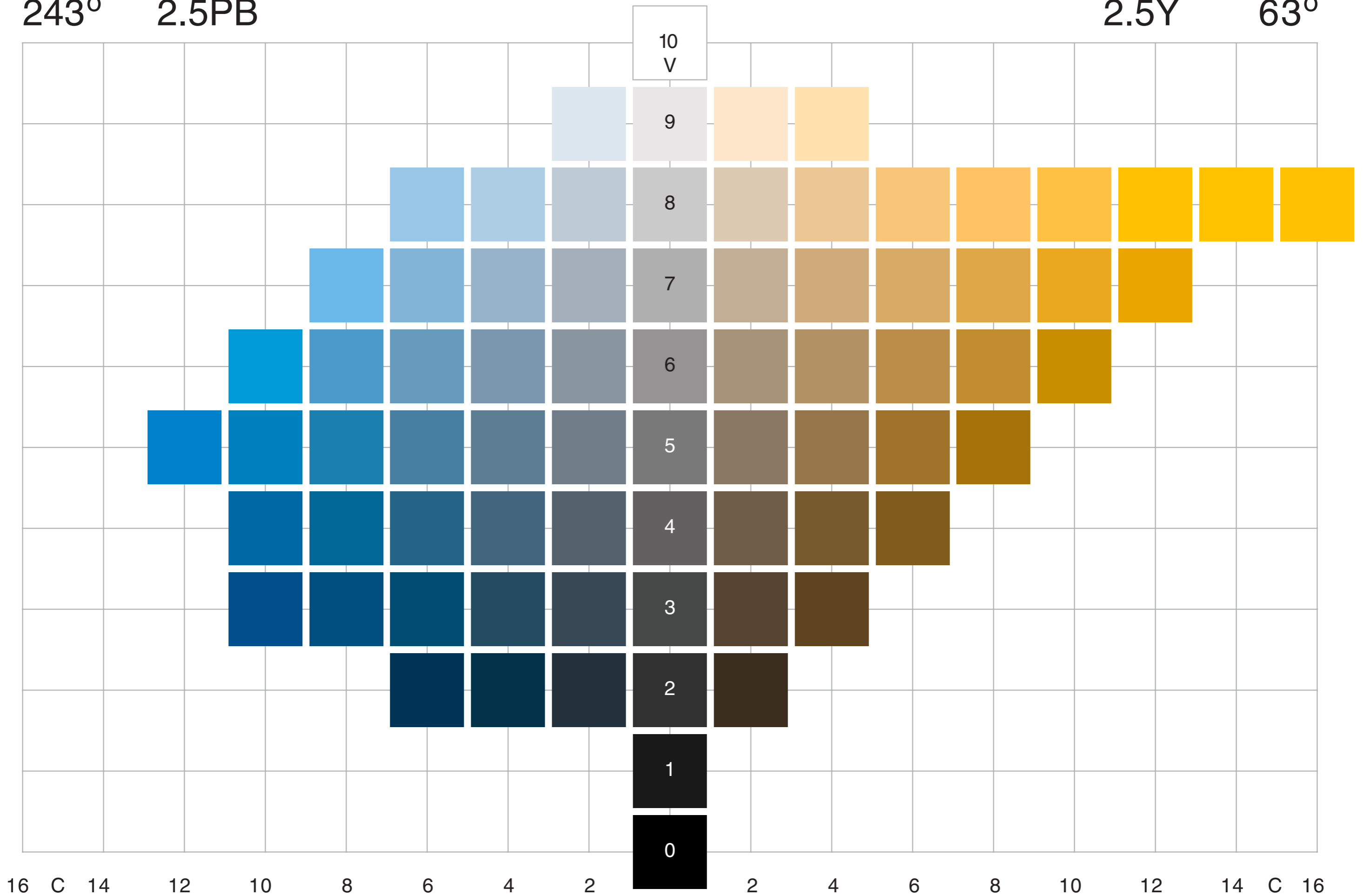
54°



16 C 14 12 10 8 6 4 2 2 4 6 8 10 12 14 C 16

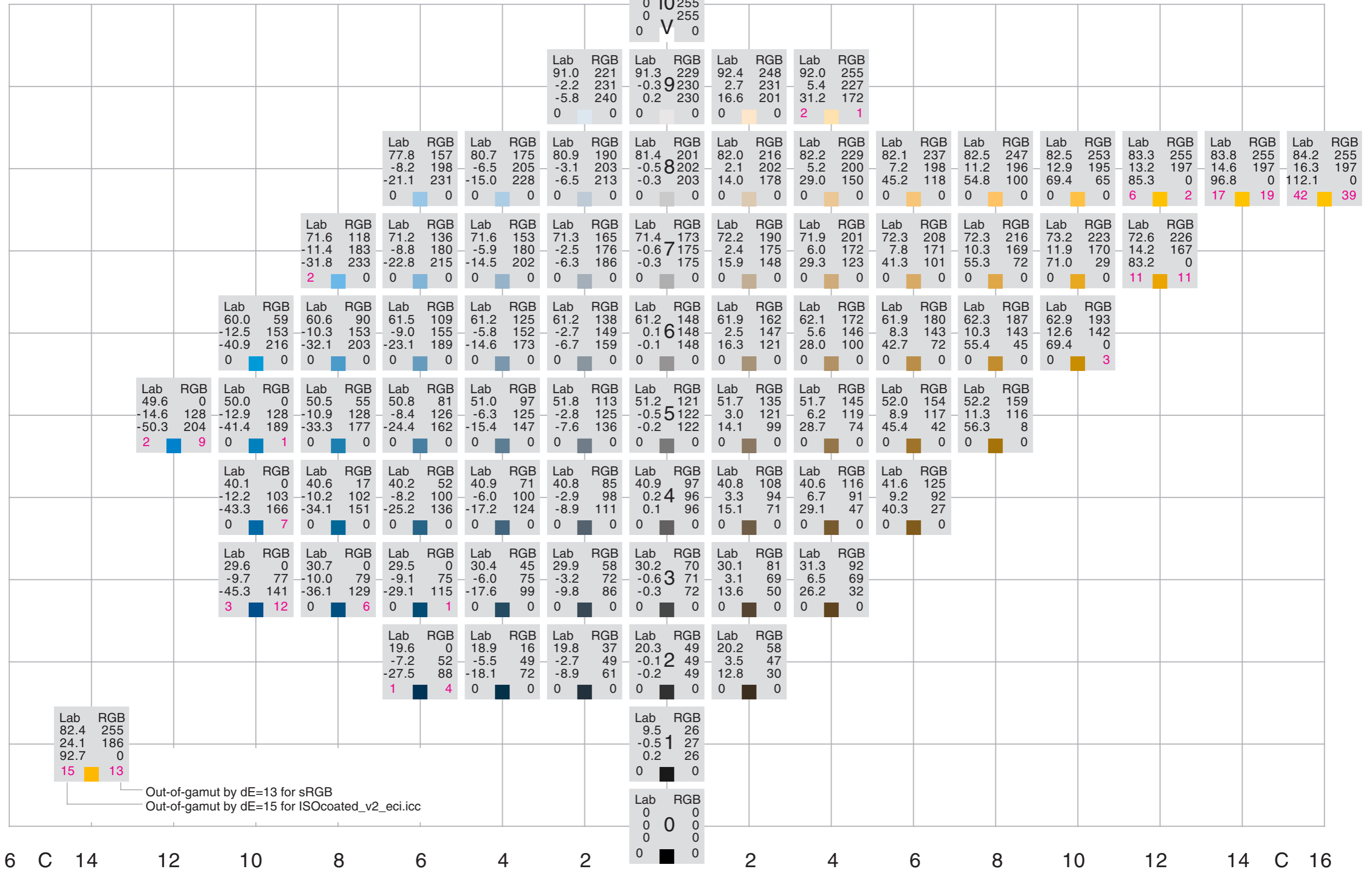
243° 2.5PB

2.5Y 63°



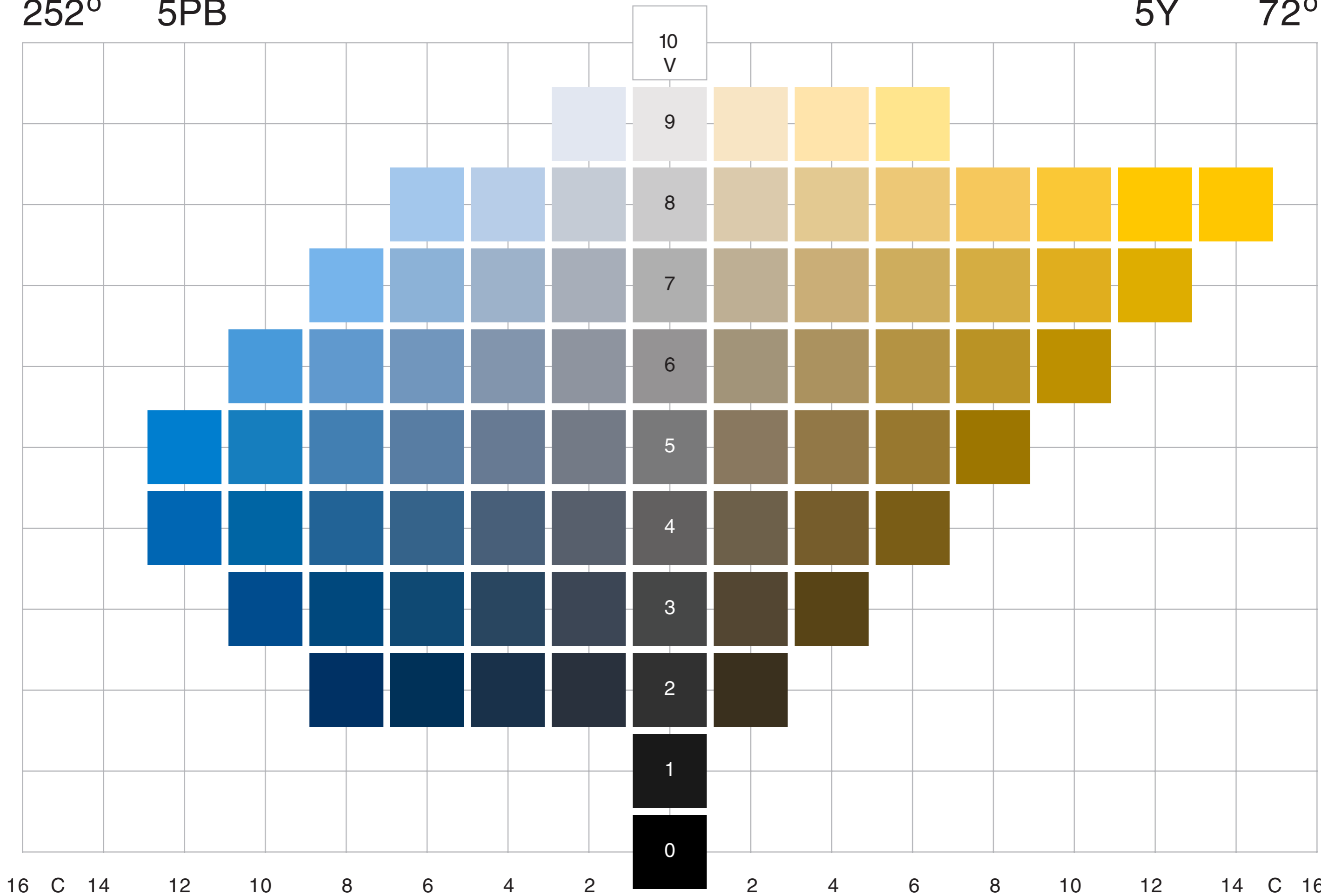
243° 2.5PB

2.5Y 63°



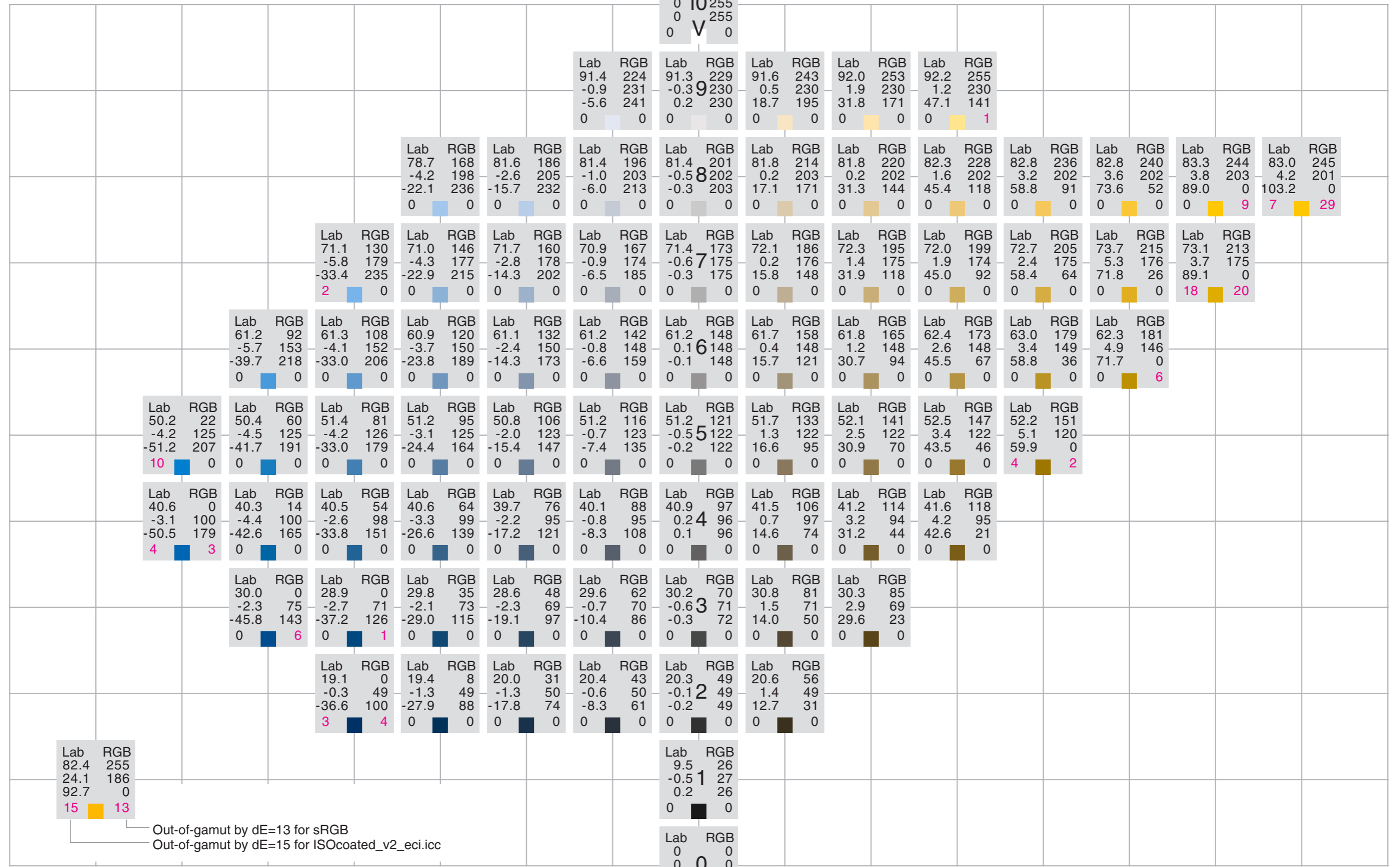
252° 5PB

5Y 72°



252° 5PB

5Y 72°

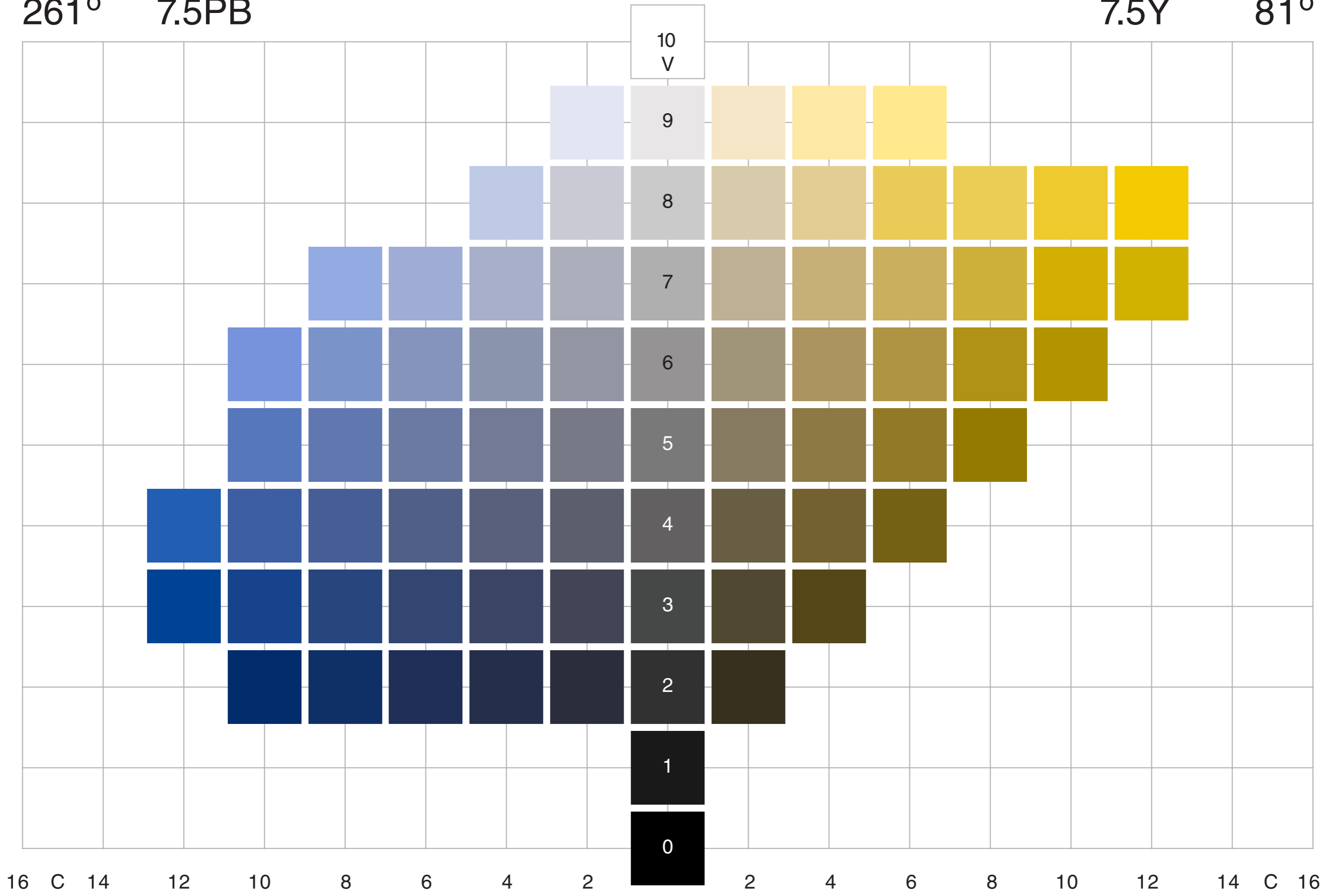


Out-of-gamut by dE=13 for sRGB
Out-of-gamut by dE=15 for ISOcoated_v2_eci.icc

16 C 14 12 10 8 6 4 2 2 4 6 8 10 12 14 C 16

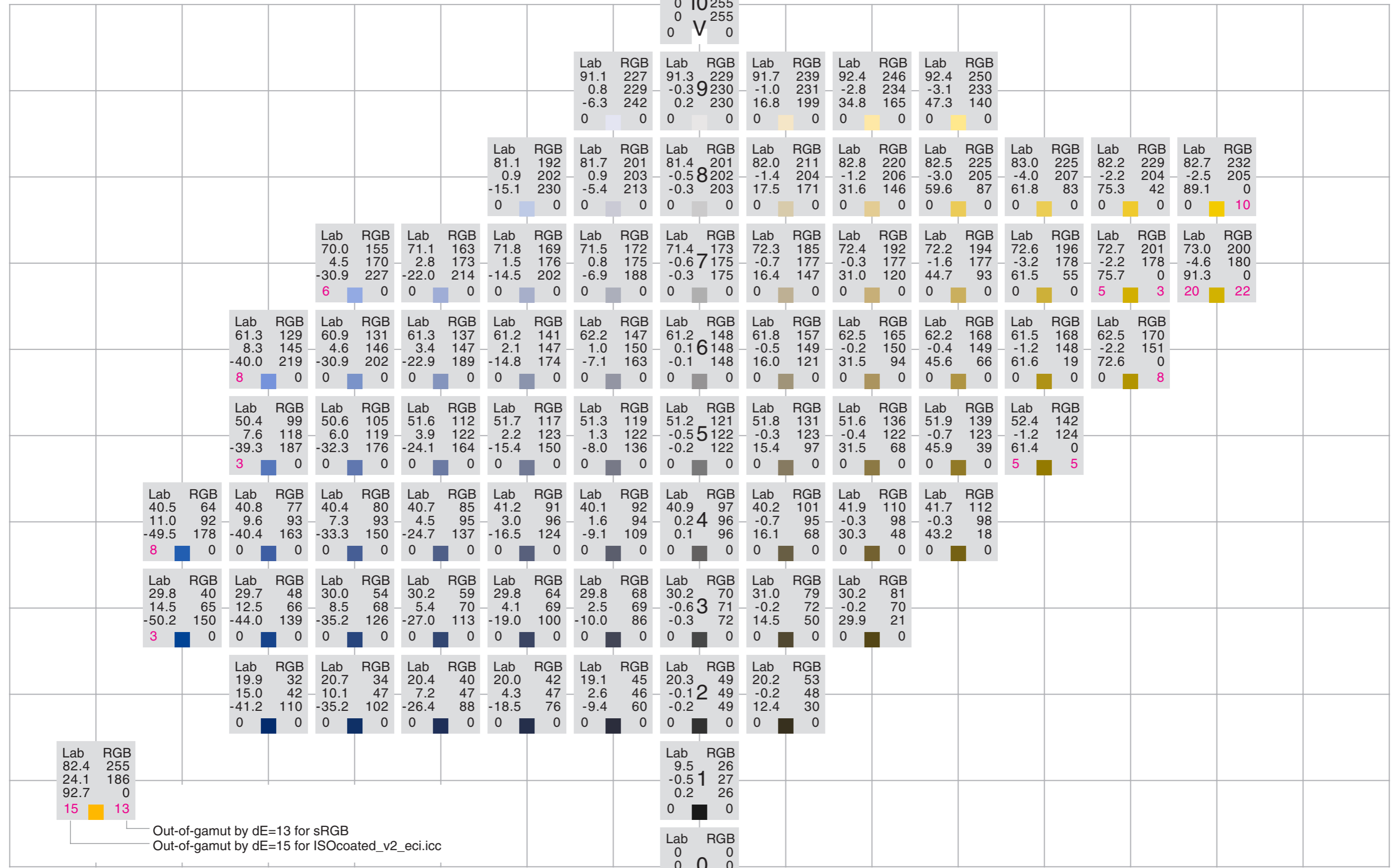
261° 7.5PB

7.5Y 81°



261° 7.5PB

7.5Y 81°



Out-of-gamut by dE=13 for sRGB
Out-of-gamut by dE=15 for ISOcoated_v2_eci.icc

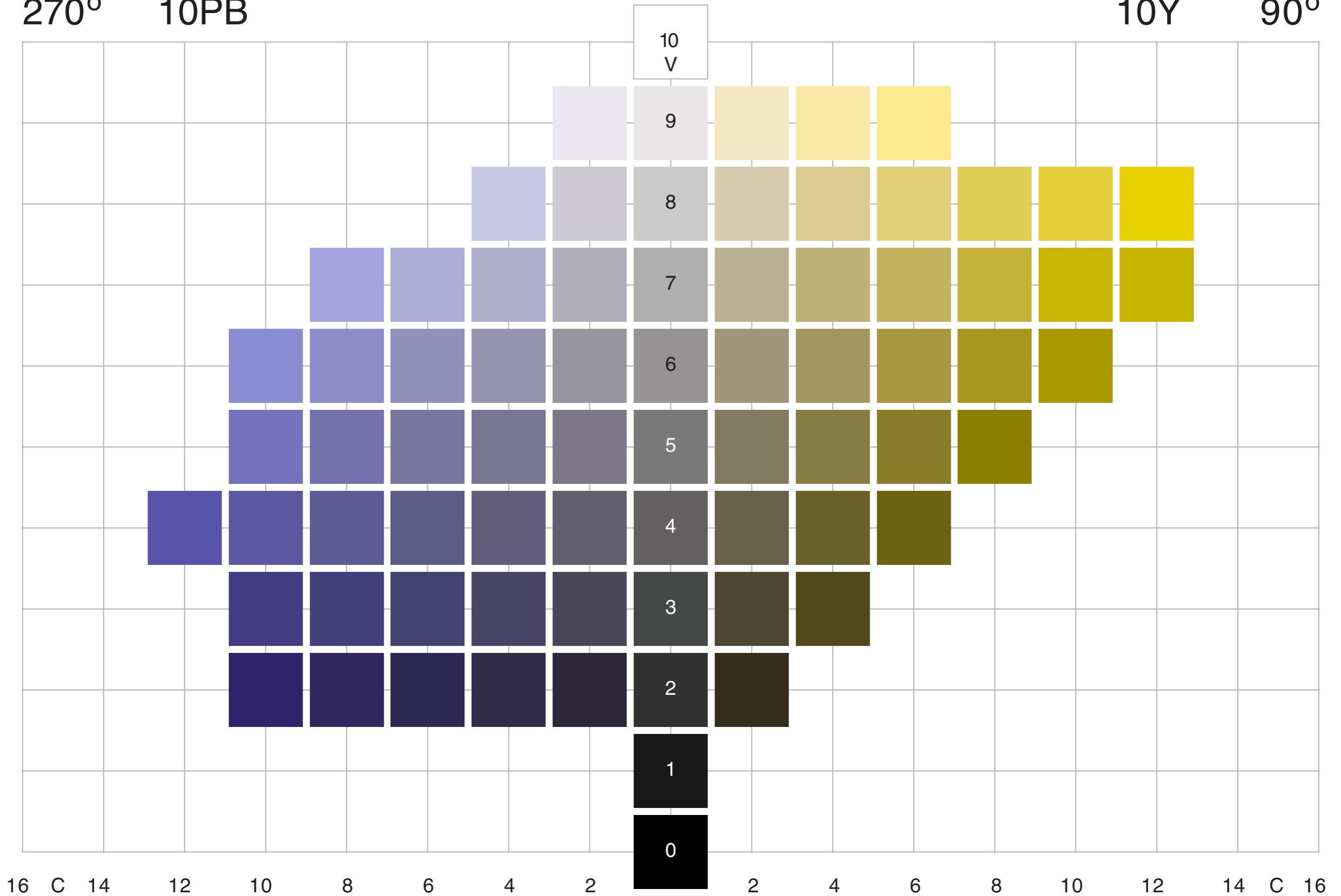
16 C 14 12 10 8 6 4 2 2 4 6 8 10 12 14 C 16

270°

10PB

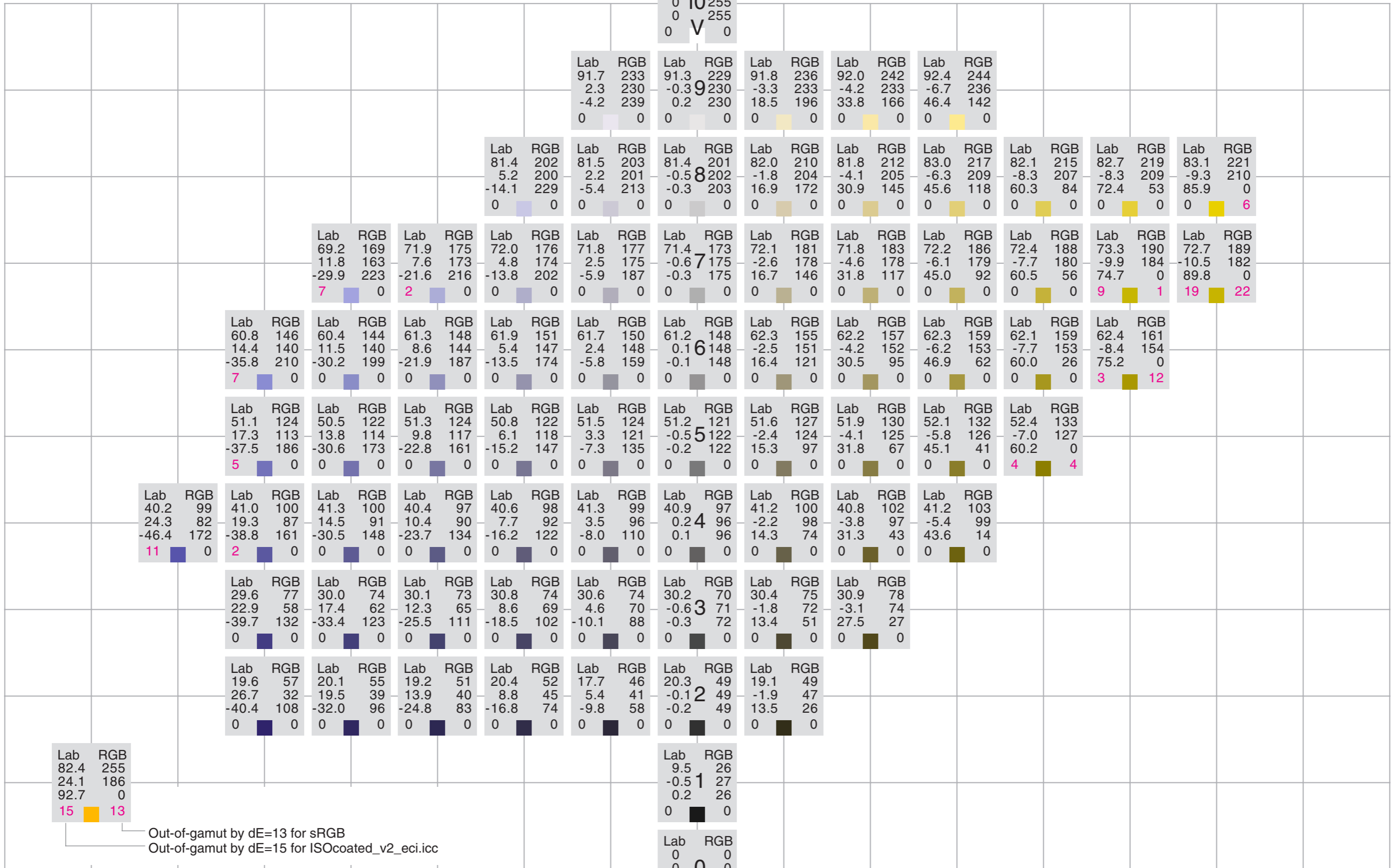
10Y

90°



270° 10PB

10Y 90°



Out-of-gamut by dE=13 for sRGB
 Out-of-gamut by dE=15 for ISOcoated_v2_eci.icc

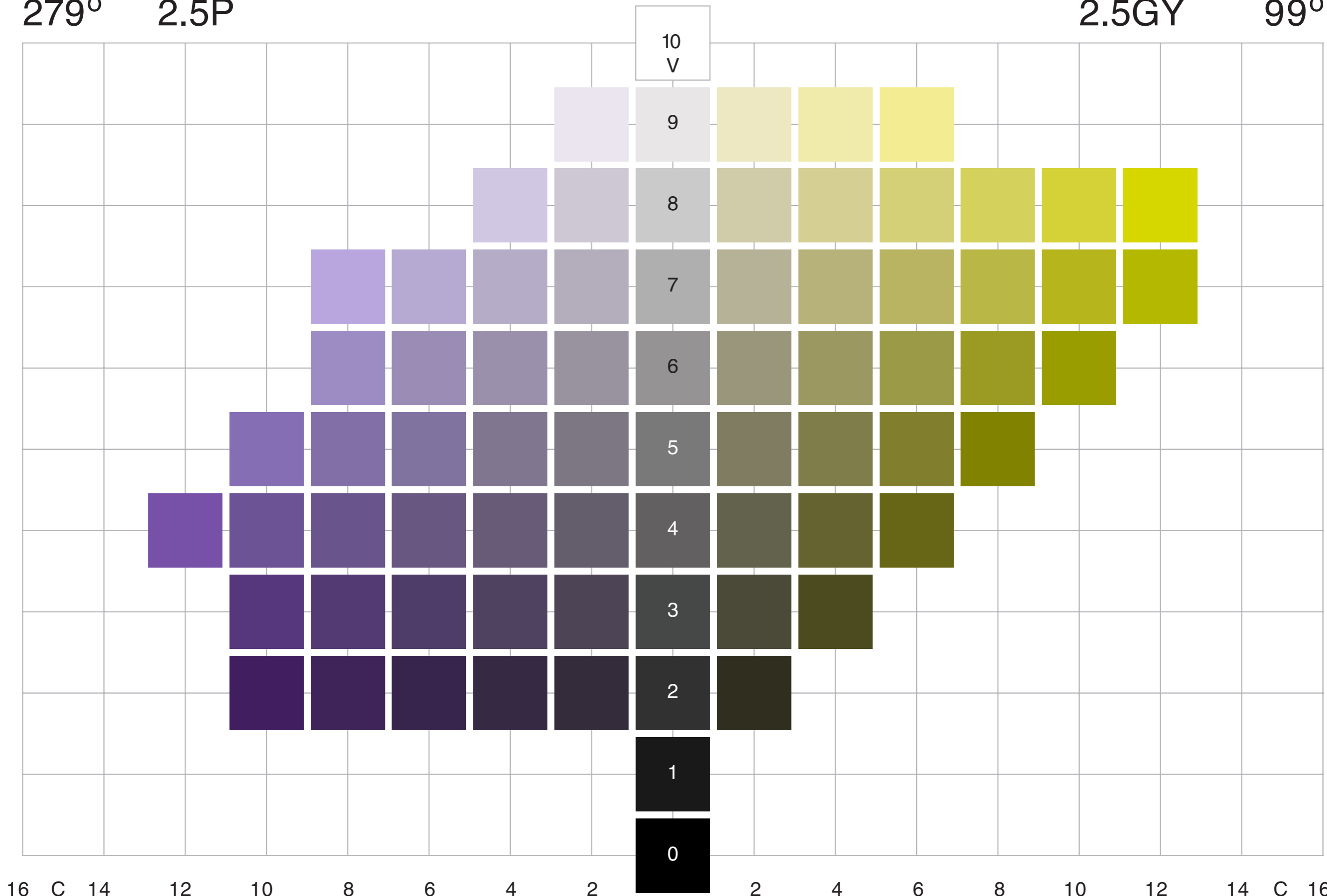
16 C 14 12 10 8 6 4 2 2 4 6 8 10 12 14 C 16

279°

2.5P

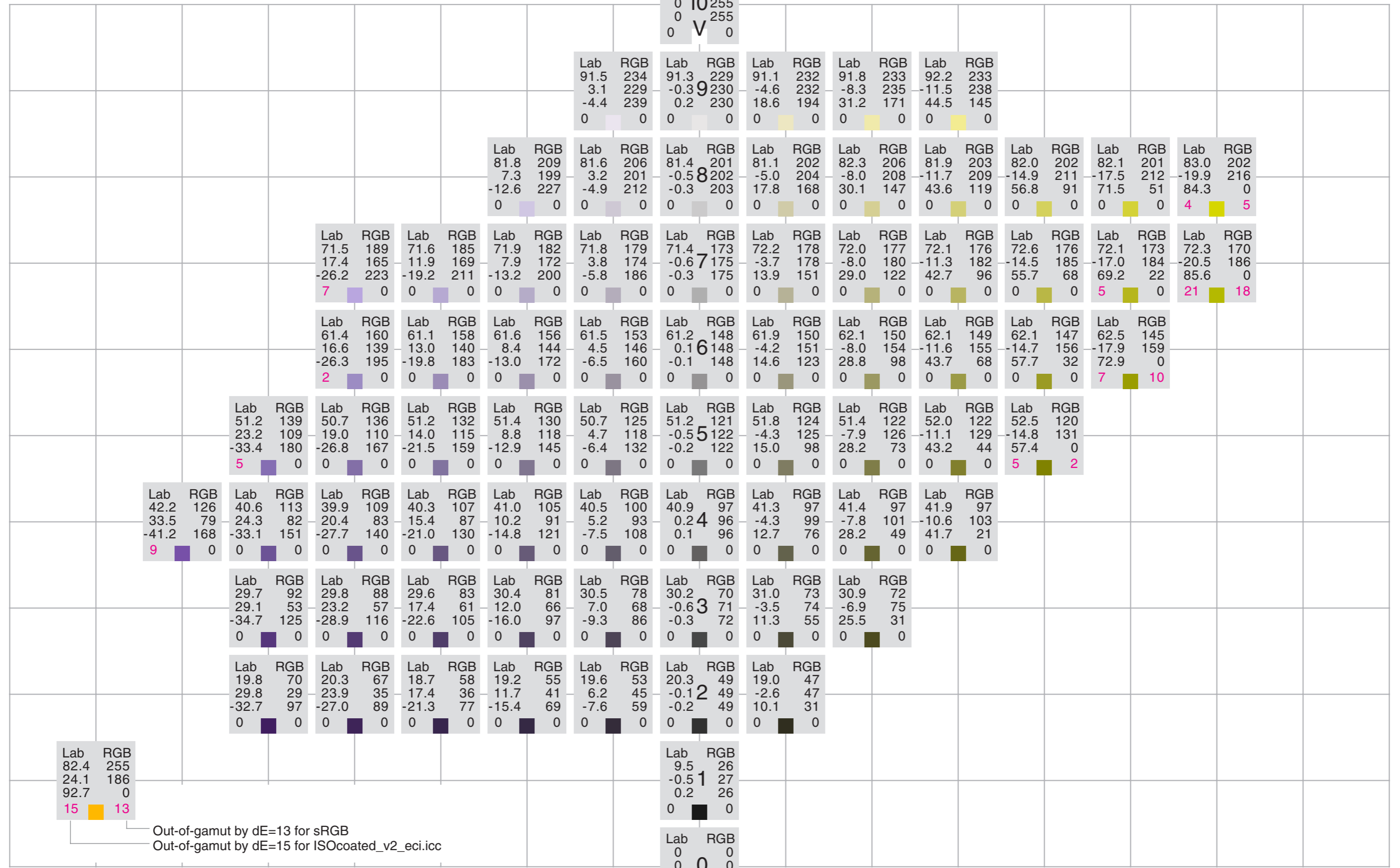
2.5GY

99°



279° 2.5P

2.5GY 99°

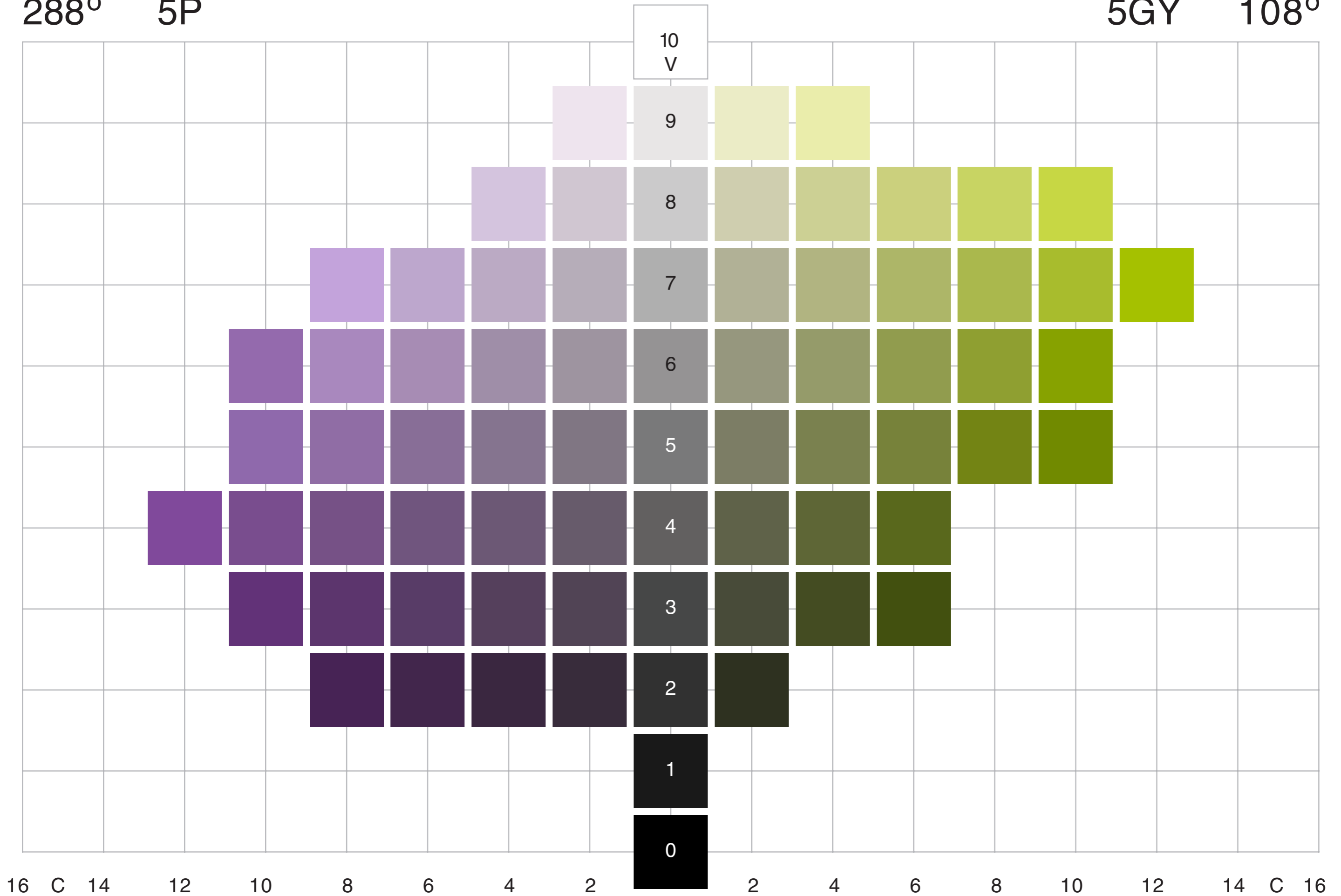


Out-of-gamut by dE=13 for sRGB
 Out-of-gamut by dE=15 for ISOcoated_v2_eci.icc

16 C 14 12 10 8 6 4 2 2 4 6 8 10 12 14 C 16

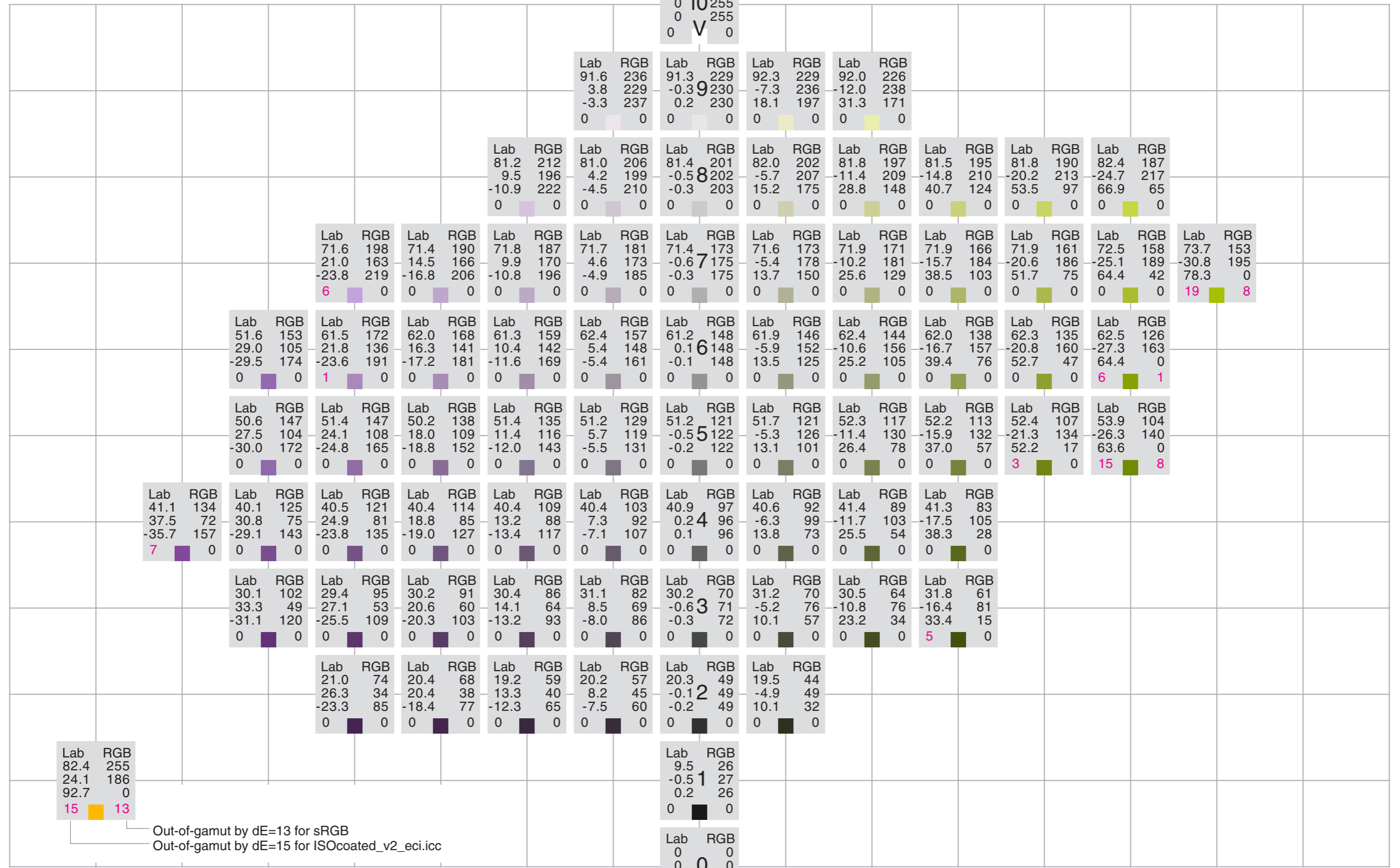
288° 5P

5GY 108°



288° 5P

5GY 108°

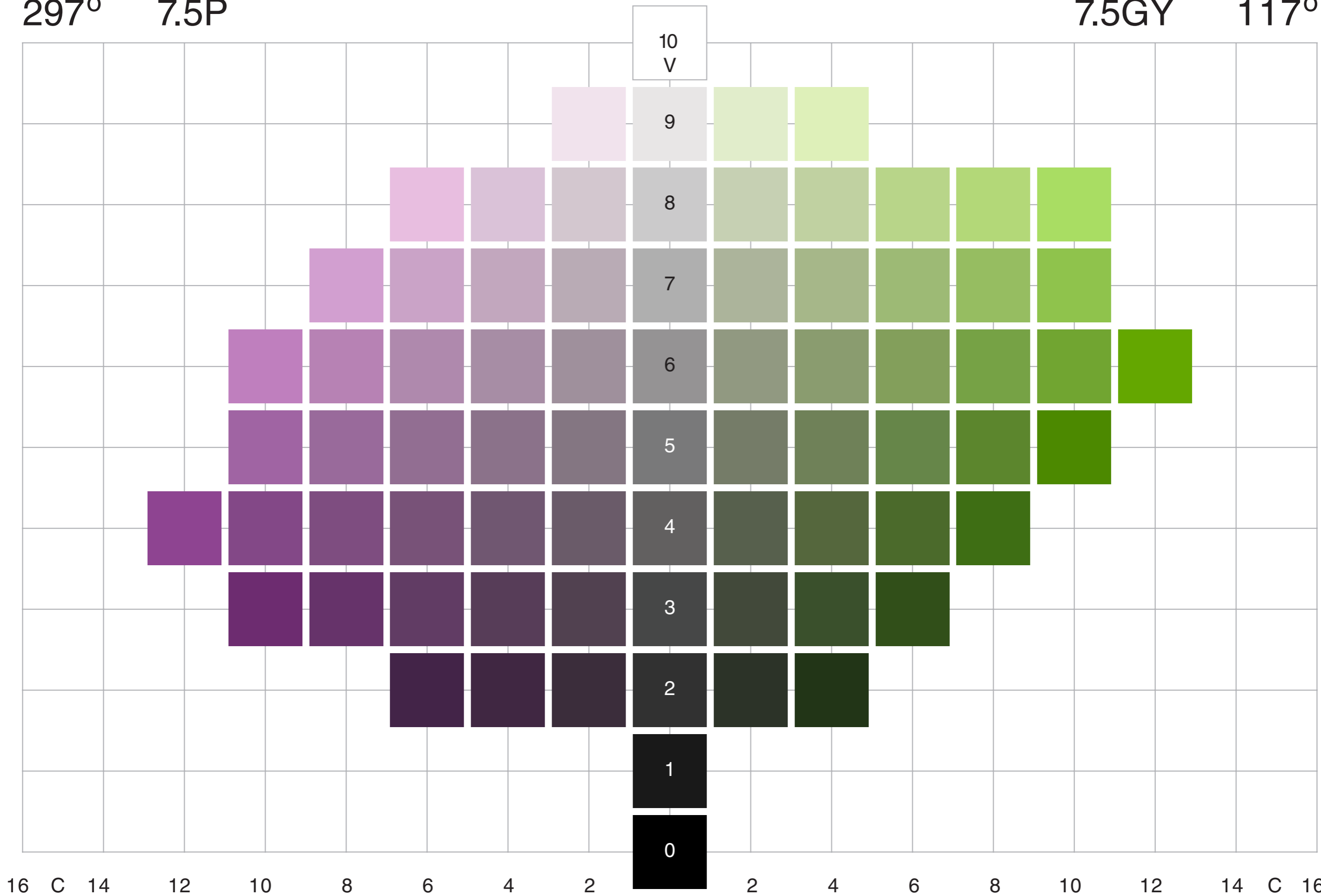


Out-of-gamut by dE=13 for sRGB
 Out-of-gamut by dE=15 for ISOcoated_v2_eci.icc

16 C 14 12 10 8 6 4 2 2 4 6 8 10 12 14 C 16

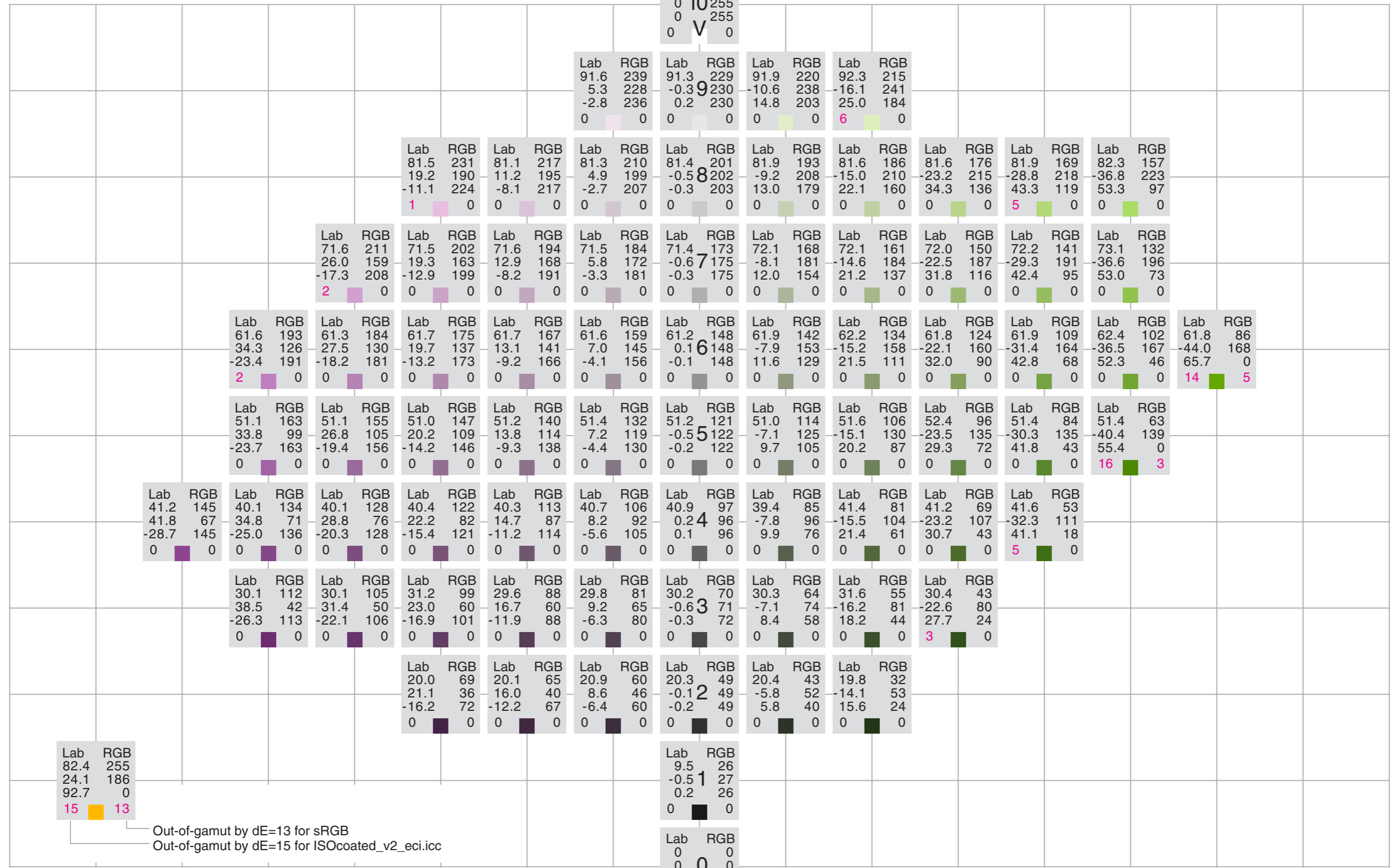
297° 7.5P

7.5GY 117°



297° 7.5P

7.5GY 117°



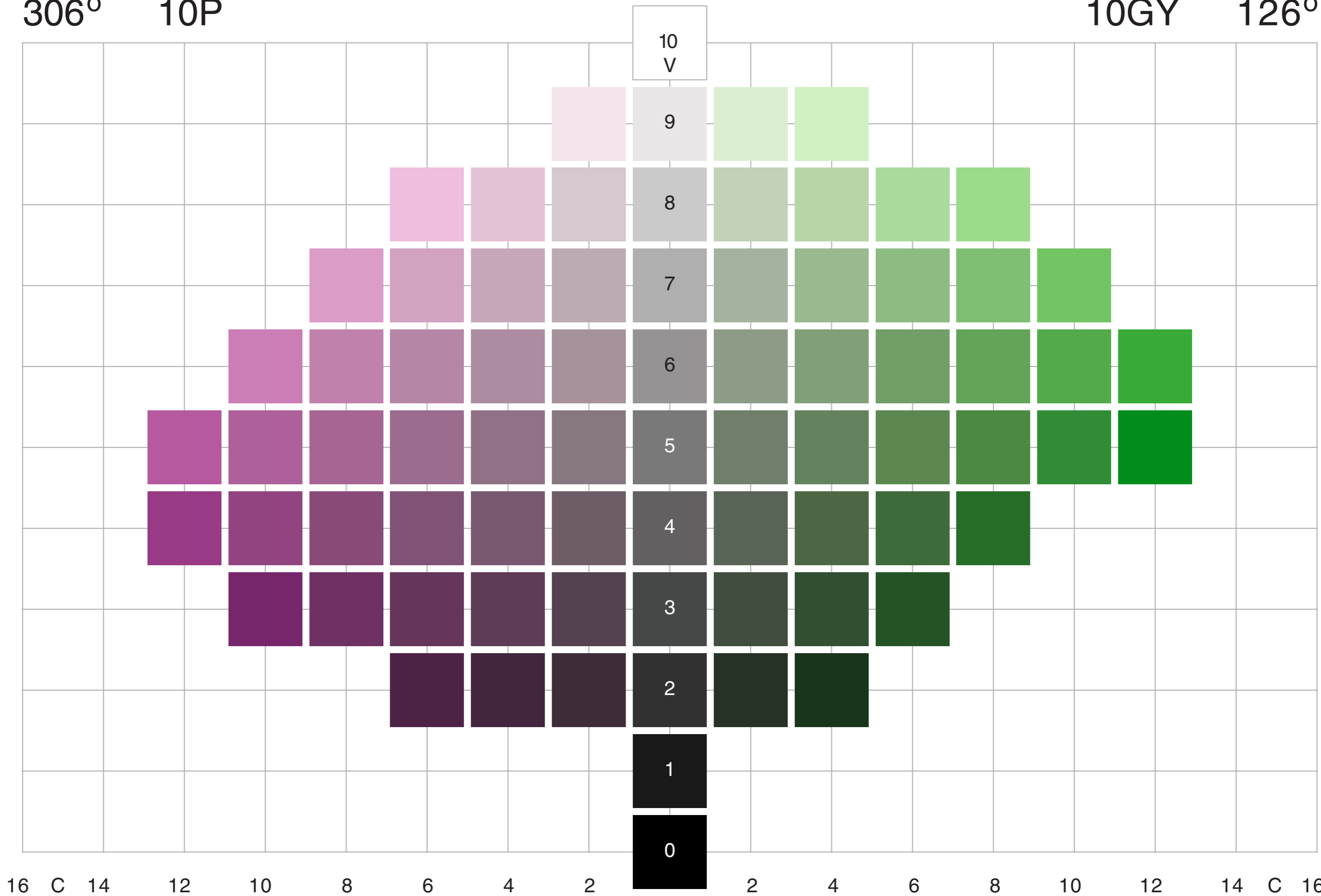
16 C 14 12 10 8 6 4 2 2 4 6 8 10 12 14 C 16

306°

10P

10GY

126°

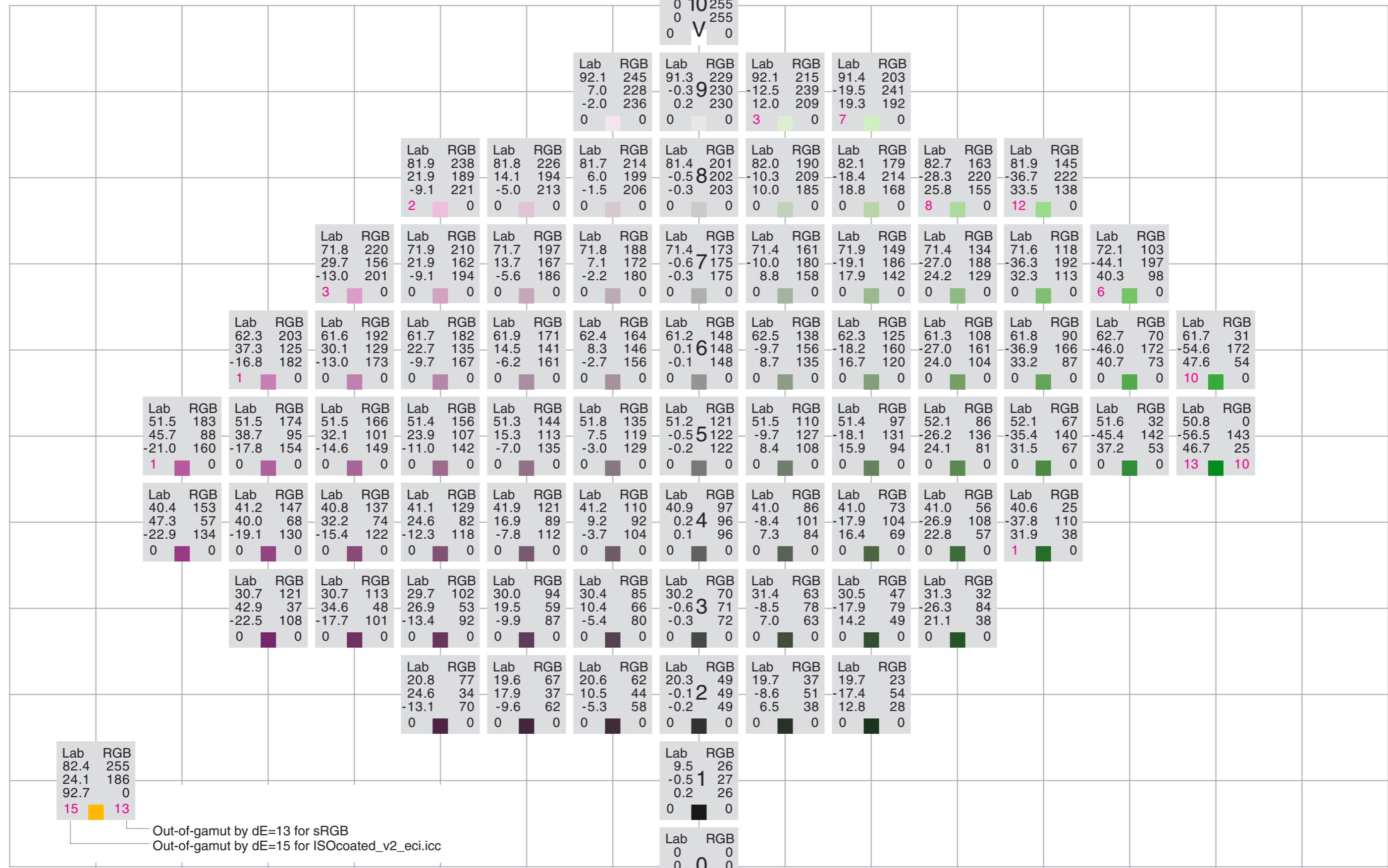


306°

10P

10GY

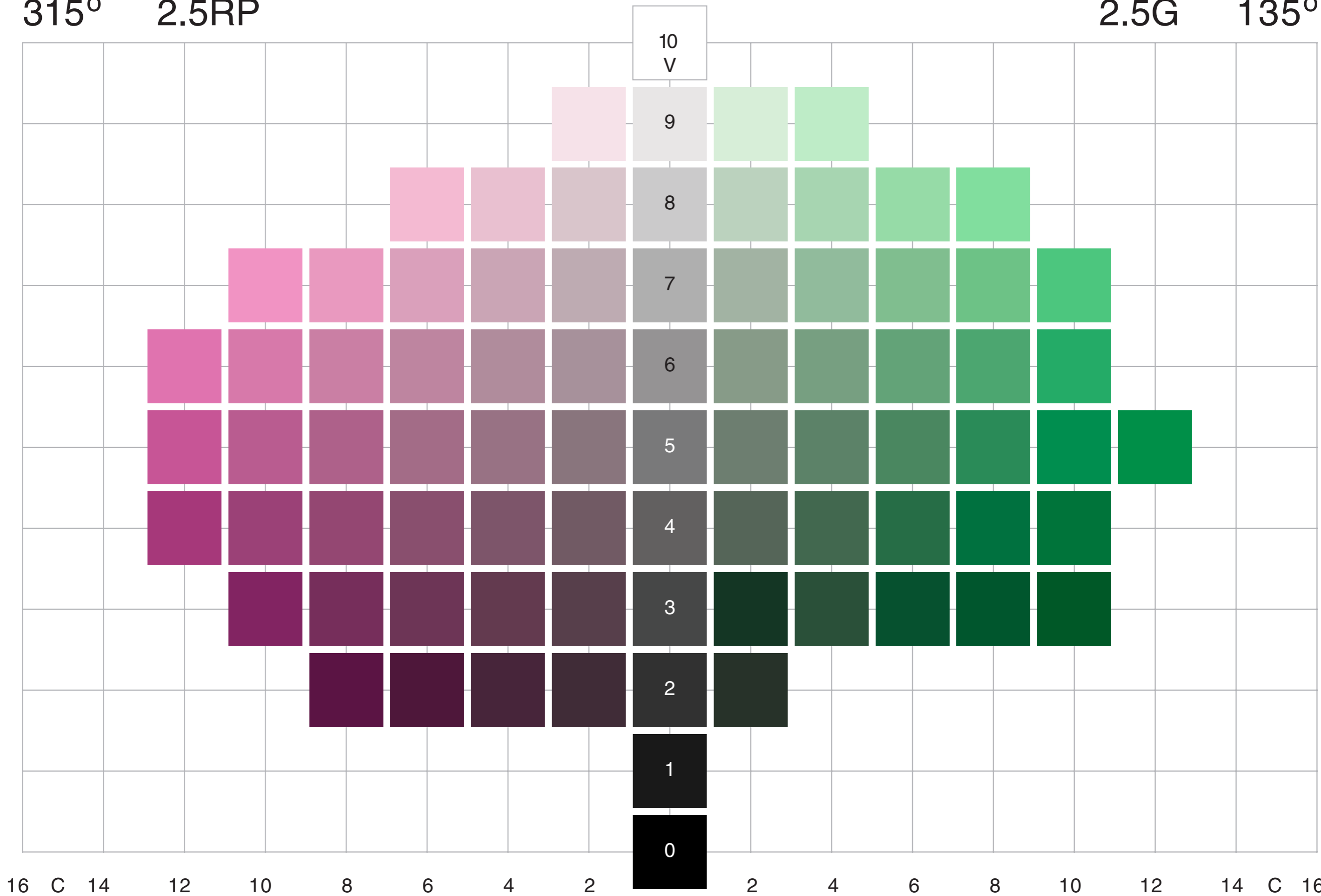
126°



Out-of-gamut by dE=13 for sRGB
 Out-of-gamut by dE=15 for ISOcoated_v2_eci.icc

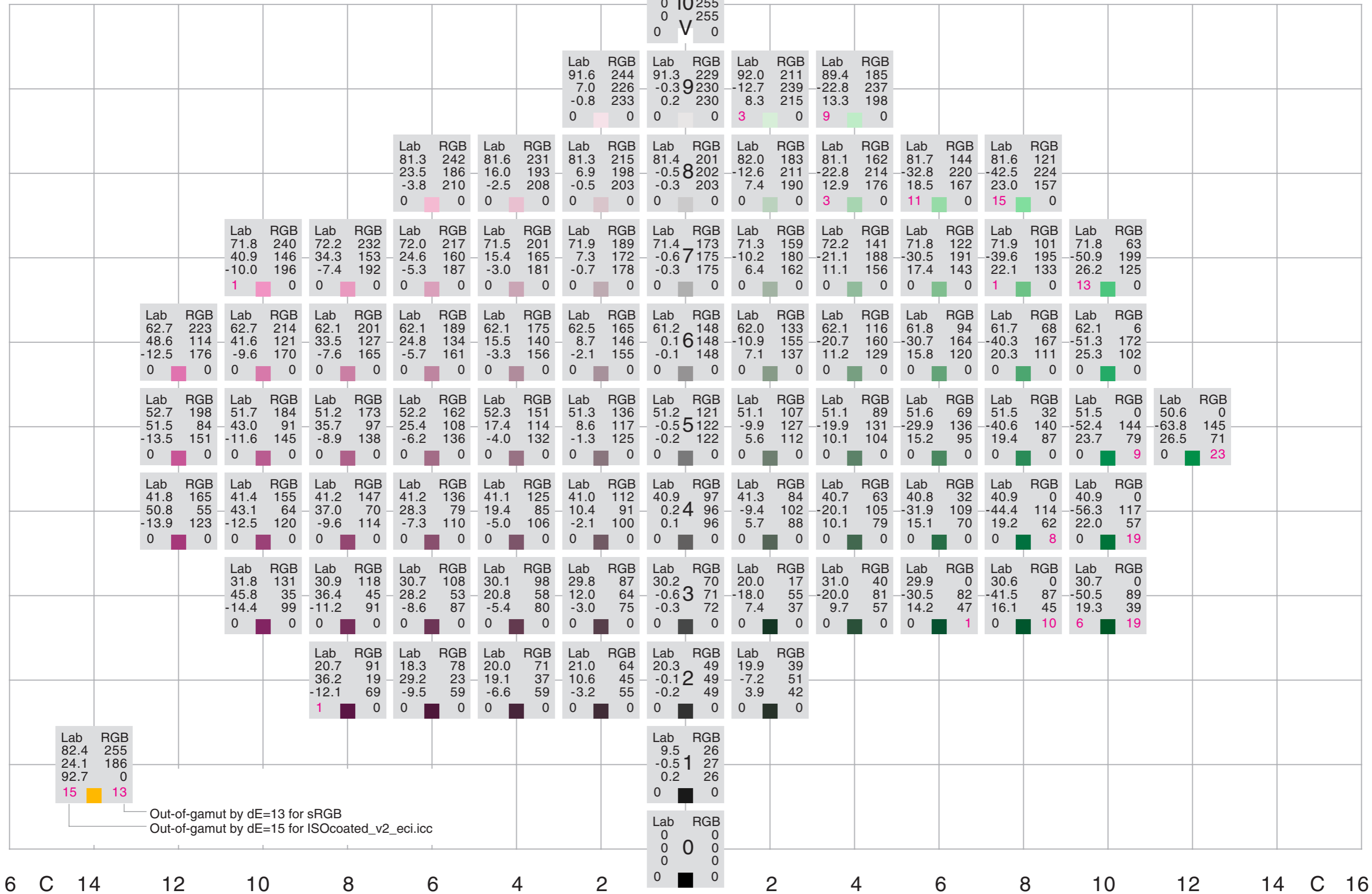
315° 2.5RP

2.5G 135°



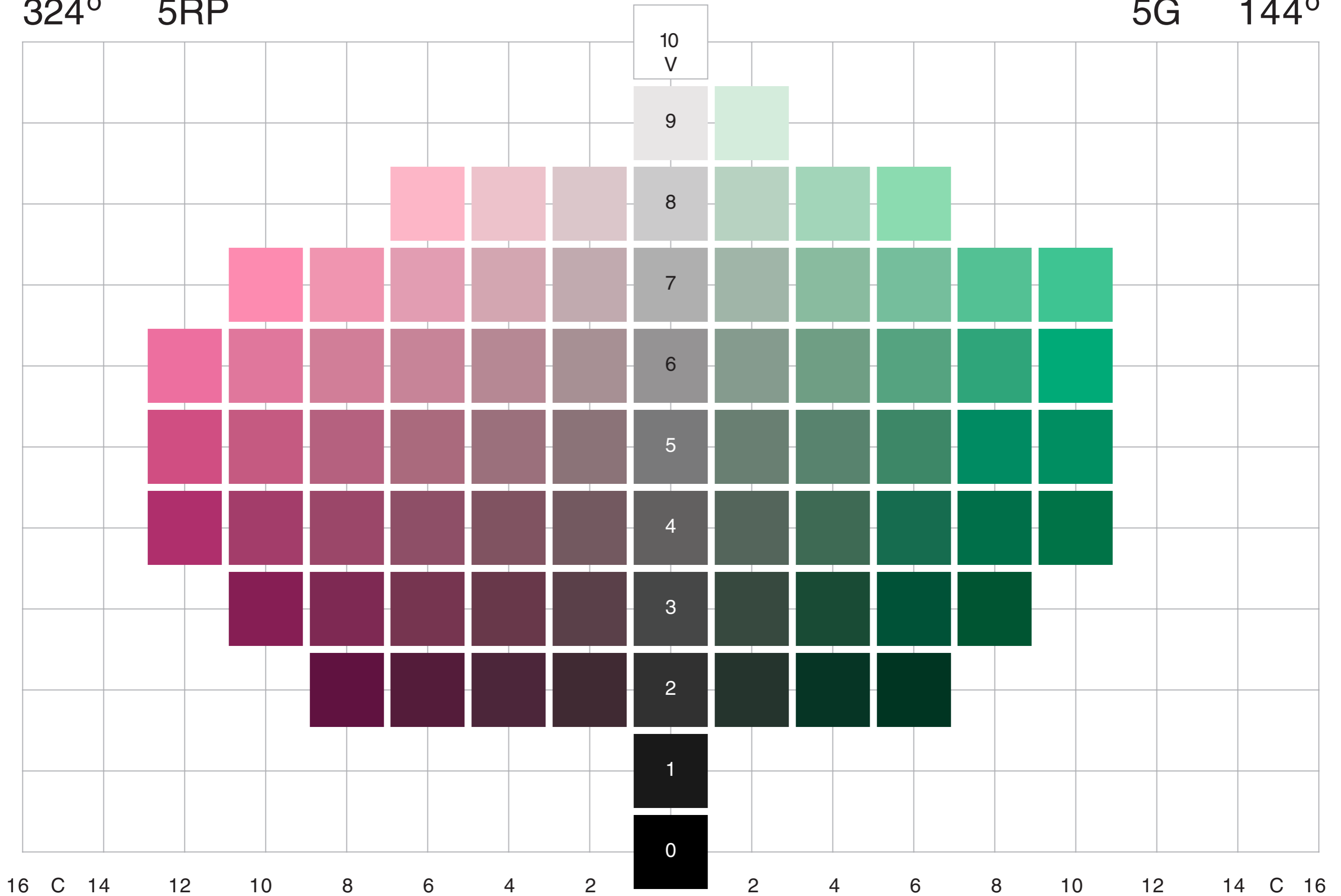
315° 2.5RP

2.5G 135°



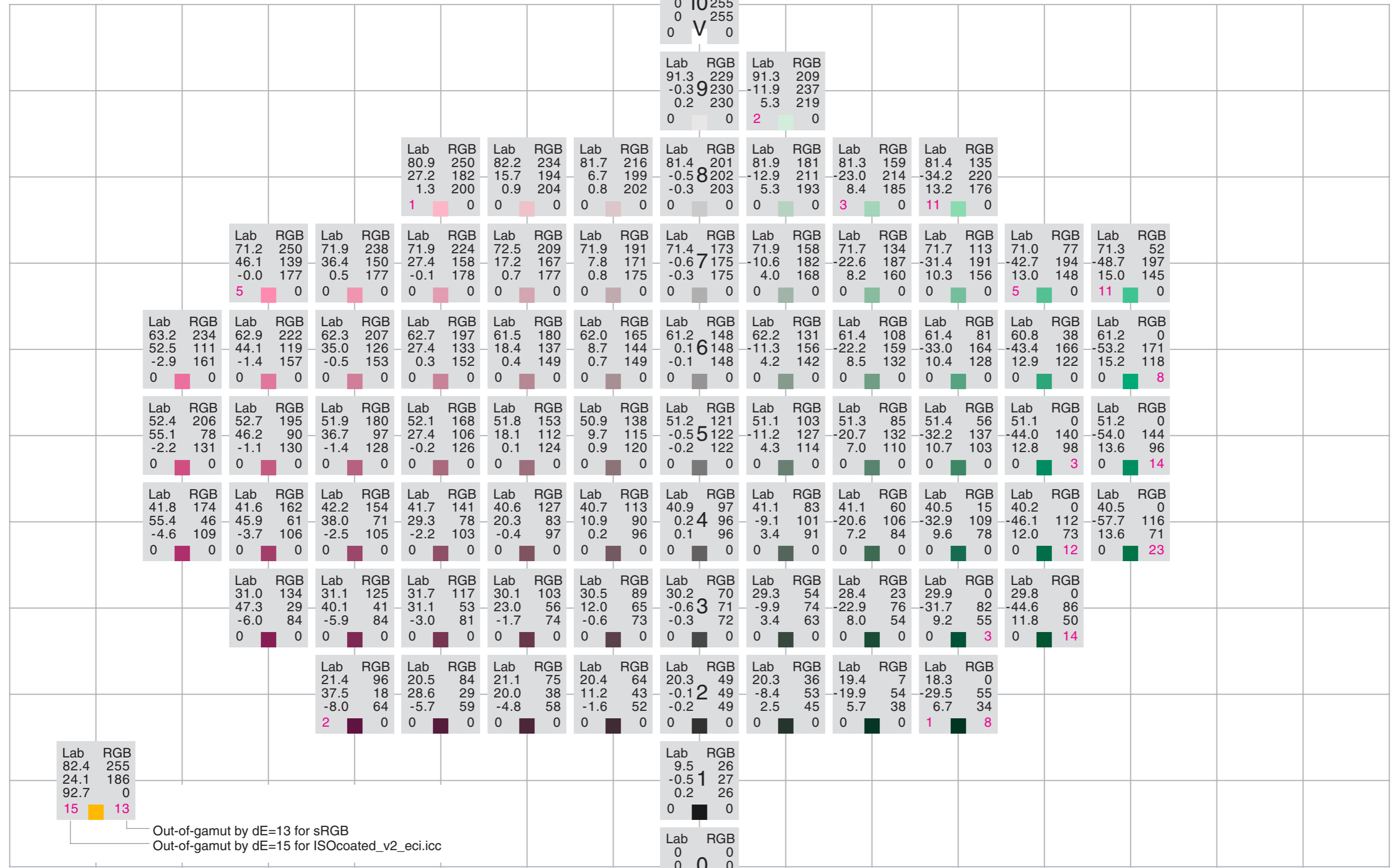
324° 5RP

5G 144°



324° 5RP

5G 144°



Lab RGB
82.4 255
24.1 186
92.7 0
15 13

Out-of-gamut by dE=13 for sRGB
Out-of-gamut by dE=15 for ISOcoated_v2_eci.icc

Lab RGB
100 255
0 255
0 255
0 0

Lab RGB
91.3 229
-0.3 230
0.2 230
0 0

Lab RGB
91.3 209
-11.9 237
5.3 219
0 0

Lab RGB
80.9 250
27.2 182
1.3 200
1 0

Lab RGB
82.2 234
15.7 194
0.9 204
0 0

Lab RGB
81.7 216
6.7 199
0.8 202
0 0

Lab RGB
81.4 201
-0.5 202
-0.3 203
0 0

Lab RGB
81.9 181
-12.9 211
5.3 193
0 0

Lab RGB
81.3 159
-23.0 214
8.4 185
0 0

Lab RGB
81.4 135
-34.2 220
13.2 176
0 0

Lab RGB
71.2 250
46.1 139
-0.0 177
5 0

Lab RGB
71.9 238
36.4 150
0.5 177
0 0

Lab RGB
71.9 224
27.4 158
-0.1 178
0 0

Lab RGB
72.5 209
17.2 167
0.7 177
0 0

Lab RGB
71.9 191
7.8 171
0.8 175
0 0

Lab RGB
71.4 173
-0.6 175
-0.3 175
0 0

Lab RGB
71.9 158
-10.6 182
4.0 168
0 0

Lab RGB
71.7 134
-22.6 187
8.2 160
0 0

Lab RGB
71.7 113
-31.4 191
10.3 156
0 0

Lab RGB
71.0 77
-42.7 194
13.0 148
5 0

Lab RGB
71.3 52
-48.7 197
15.0 145
11 0

Lab RGB
63.2 234
52.5 111
-2.9 161
0 0

Lab RGB
62.9 222
44.1 119
-1.4 157
0 0

Lab RGB
62.3 207
35.0 126
-0.5 153
0 0

Lab RGB
62.7 197
27.4 133
0.3 152
0 0

Lab RGB
61.5 180
18.4 137
0.4 149
0 0

Lab RGB
62.0 165
8.7 144
0.7 149
0 0

Lab RGB
61.2 148
0.1 148
-0.1 148
0 0

Lab RGB
62.2 131
-11.3 156
4.2 142
0 0

Lab RGB
61.4 108
-22.2 159
8.5 132
0 0

Lab RGB
61.4 81
-33.0 164
10.4 128
0 0

Lab RGB
60.8 38
-43.4 166
12.9 122
0 0

Lab RGB
61.2 0
-53.2 171
15.2 118
0 8

Lab RGB
52.4 206
55.1 78
-2.2 131
0 0

Lab RGB
52.7 195
46.2 90
-1.1 130
0 0

Lab RGB
51.9 180
36.7 97
-1.4 128
0 0

Lab RGB
52.1 168
27.4 106
-0.2 126
0 0

Lab RGB
51.8 153
18.1 112
0.1 124
0 0

Lab RGB
50.9 138
9.7 115
0.9 120
0 0

Lab RGB
51.2 121
-0.5 122
-0.2 122
0 0

Lab RGB
51.1 103
-11.2 127
4.3 114
0 0

Lab RGB
51.3 85
-20.7 132
7.0 110
0 0

Lab RGB
51.4 56
-32.2 137
10.7 103
0 0

Lab RGB
51.1 0
-44.0 140
12.8 98
0 3

Lab RGB
51.2 0
-54.0 144
13.6 96
0 14

Lab RGB
41.8 174
55.4 46
-4.6 109
0 0

Lab RGB
41.6 162
45.9 61
-3.7 106
0 0

Lab RGB
42.2 154
38.0 71
-2.5 105
0 0

Lab RGB
41.7 141
29.3 78
-2.2 103
0 0

Lab RGB
40.6 127
20.3 83
-0.4 97
0 0

Lab RGB
40.7 113
10.9 90
0.2 96
0 0

Lab RGB
40.9 97
0.2 96
0.1 96
0 0

Lab RGB
41.1 83
-9.1 101
3.4 91
0 0

Lab RGB
41.1 60
-20.6 106
7.2 84
0 0

Lab RGB
40.5 15
-32.9 109
9.6 78
0 0

Lab RGB
40.2 0
-46.1 112
12.0 73
0 12

Lab RGB
40.5 0
-57.7 116
13.6 71
0 23

Lab RGB
31.0 134
47.3 29
-6.0 84
0 0

Lab RGB
31.1 125
40.1 41
-5.9 84
0 0

Lab RGB
31.7 117
31.1 53
-3.0 81
0 0

Lab RGB
30.1 103
23.0 56
-1.7 74
0 0

Lab RGB
30.5 89
12.0 65
-0.6 73
0 0

Lab RGB
30.2 70
-0.6 71
-0.3 72
0 0

Lab RGB
29.3 54
-9.9 74
3.4 63
0 0

Lab RGB
28.4 23
-22.9 76
8.0 54
0 0

Lab RGB
29.9 0
-31.7 82
9.2 55
0 3

Lab RGB
29.8 0
-44.6 86
11.8 50
0 14

Lab RGB
21.4 96
37.5 18
-8.0 64
2 0

Lab RGB
20.5 84
28.6 29
-5.7 59
0 0

Lab RGB
21.1 75
20.0 38
-4.8 58
0 0

Lab RGB
20.4 64
11.2 43
-1.6 52
0 0

Lab RGB
20.3 49
-0.1 49
-0.2 49
0 0

Lab RGB
20.3 36
-8.4 53
2.5 45
0 0

Lab RGB
19.4 7
-19.9 54
5.7 38
0 0

Lab RGB
18.3 0
-29.5 55
6.7 34
1 8

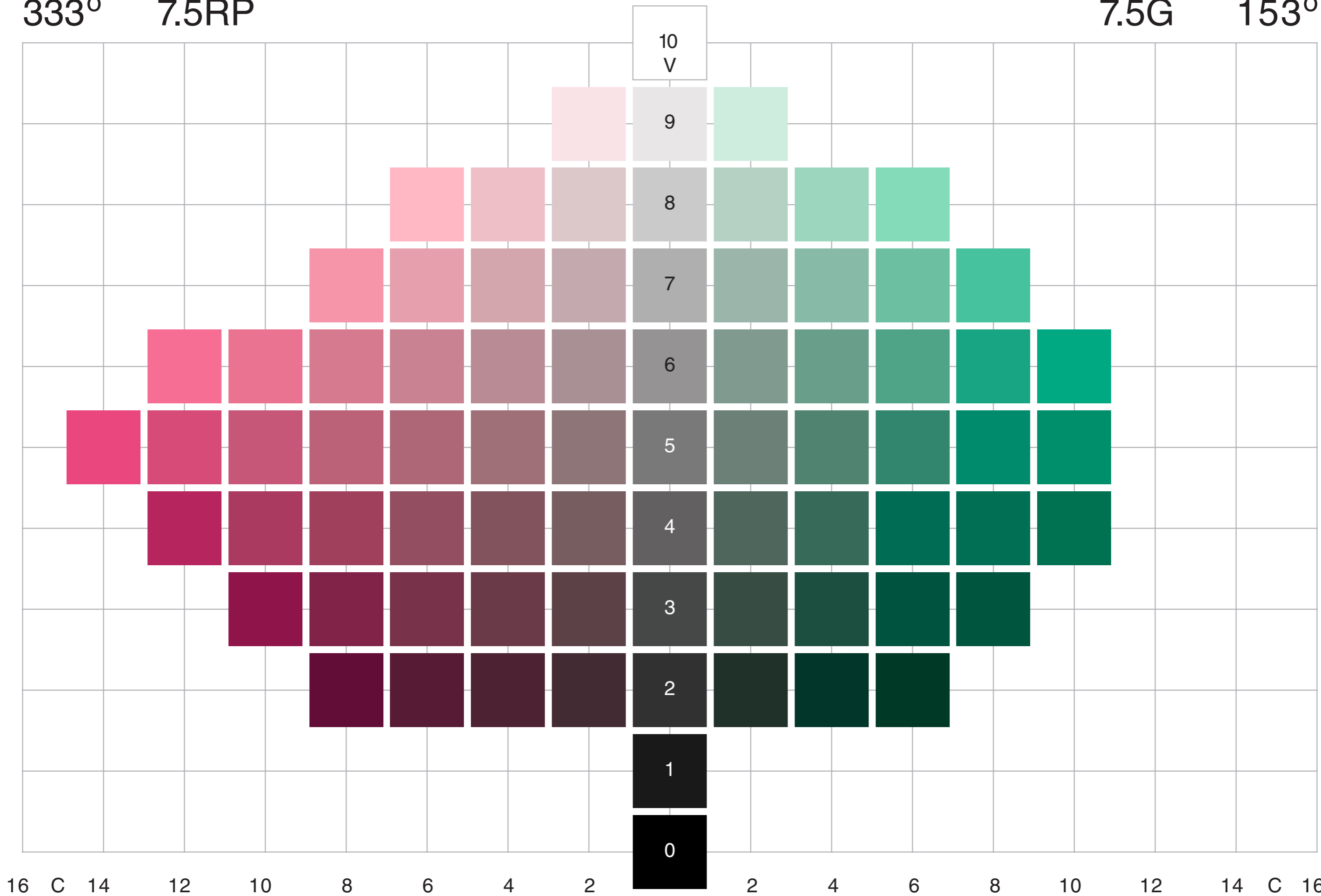
Lab RGB
9.5 26
-0.5 27
0.2 26
0 0

Lab RGB
0 0
0 0
0 0
0 0

16 C 14 12 10 8 6 4 2 2 4 6 8 10 12 14 C 16

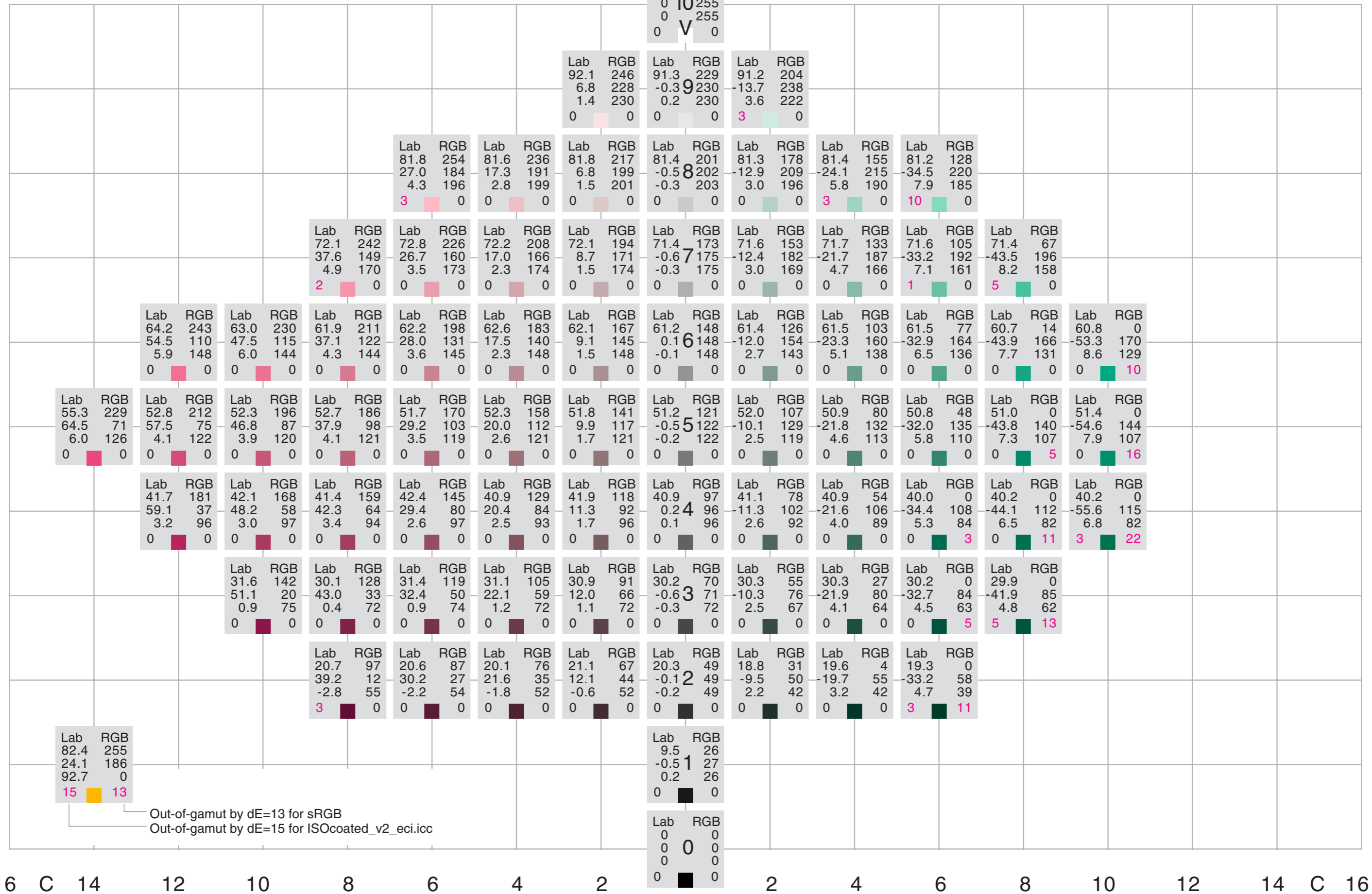
333° 7.5RP

7.5G 153°



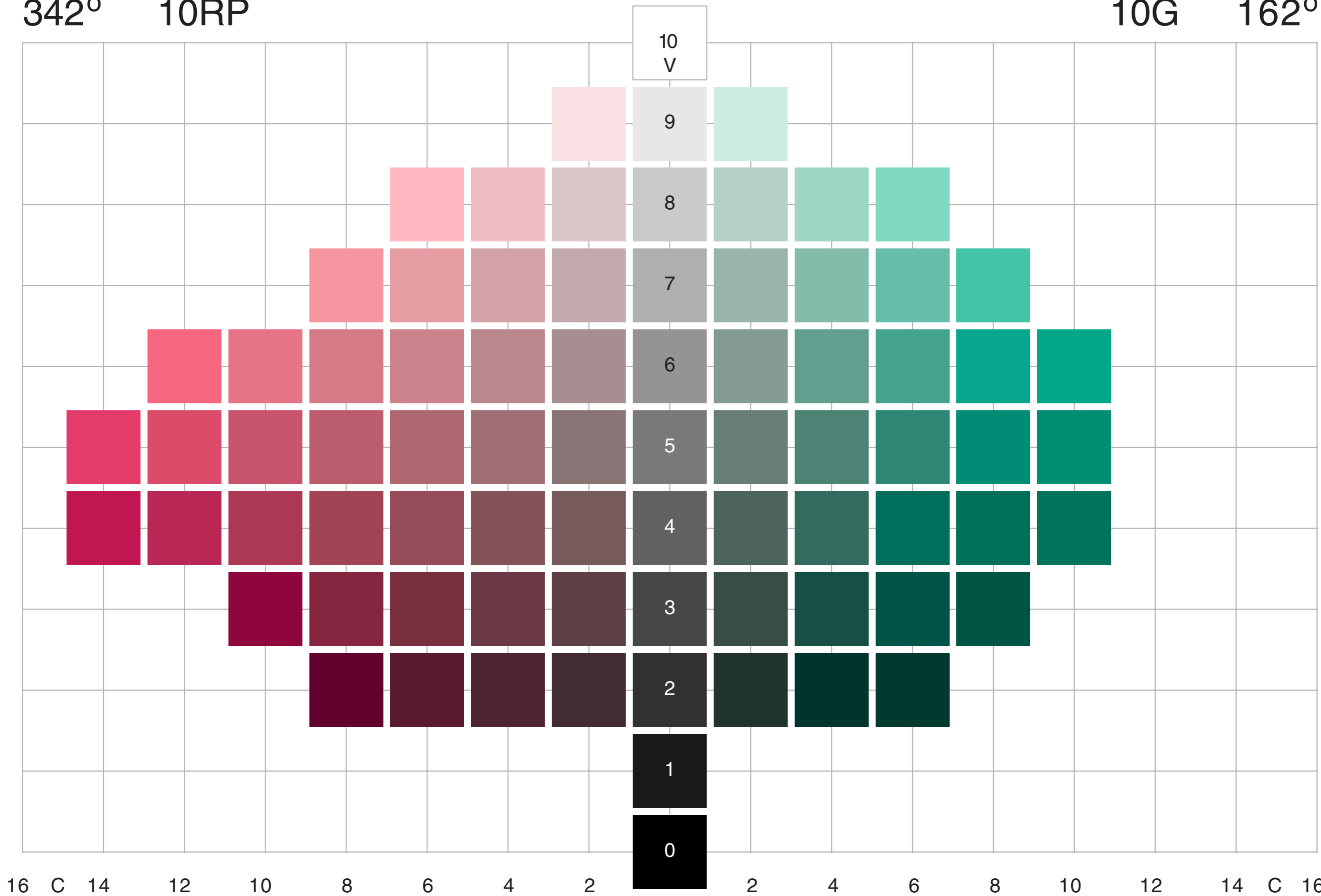
333° 7.5RP

7.5G 153°



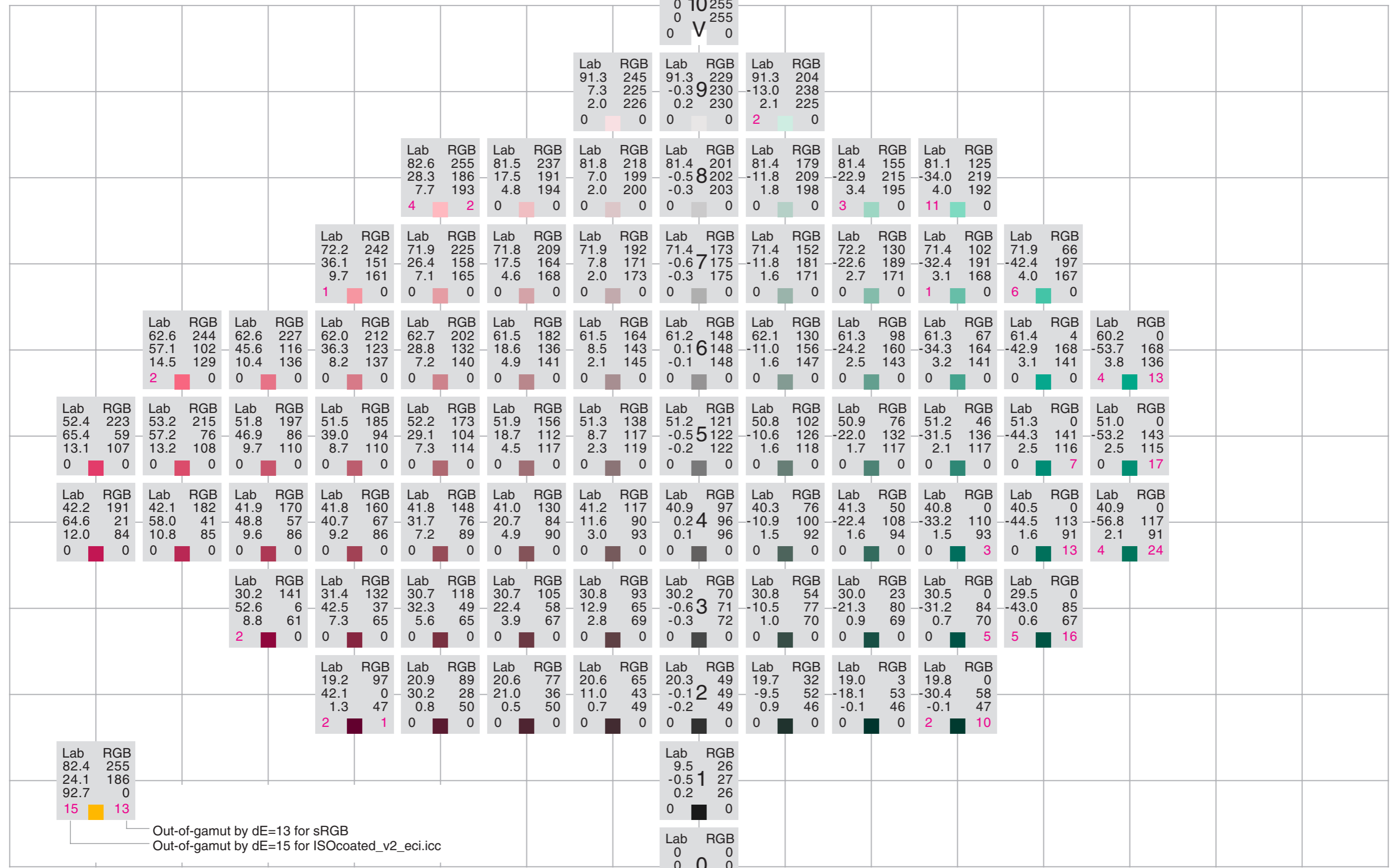
342° 10RP

10G 162°



342° 10RP

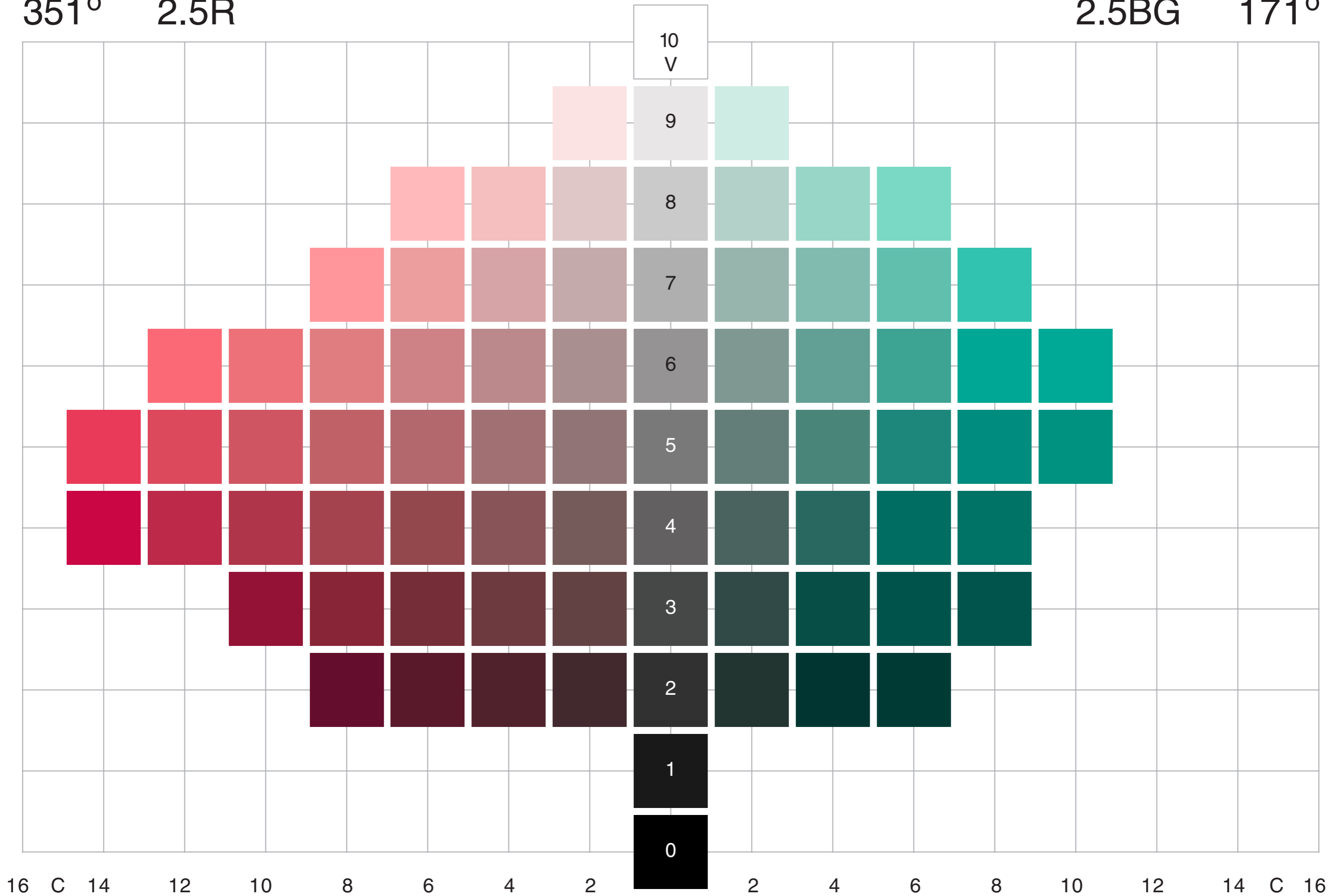
10G 162°



16 C 14 12 10 8 6 4 2 2 4 6 8 10 12 14 C 16

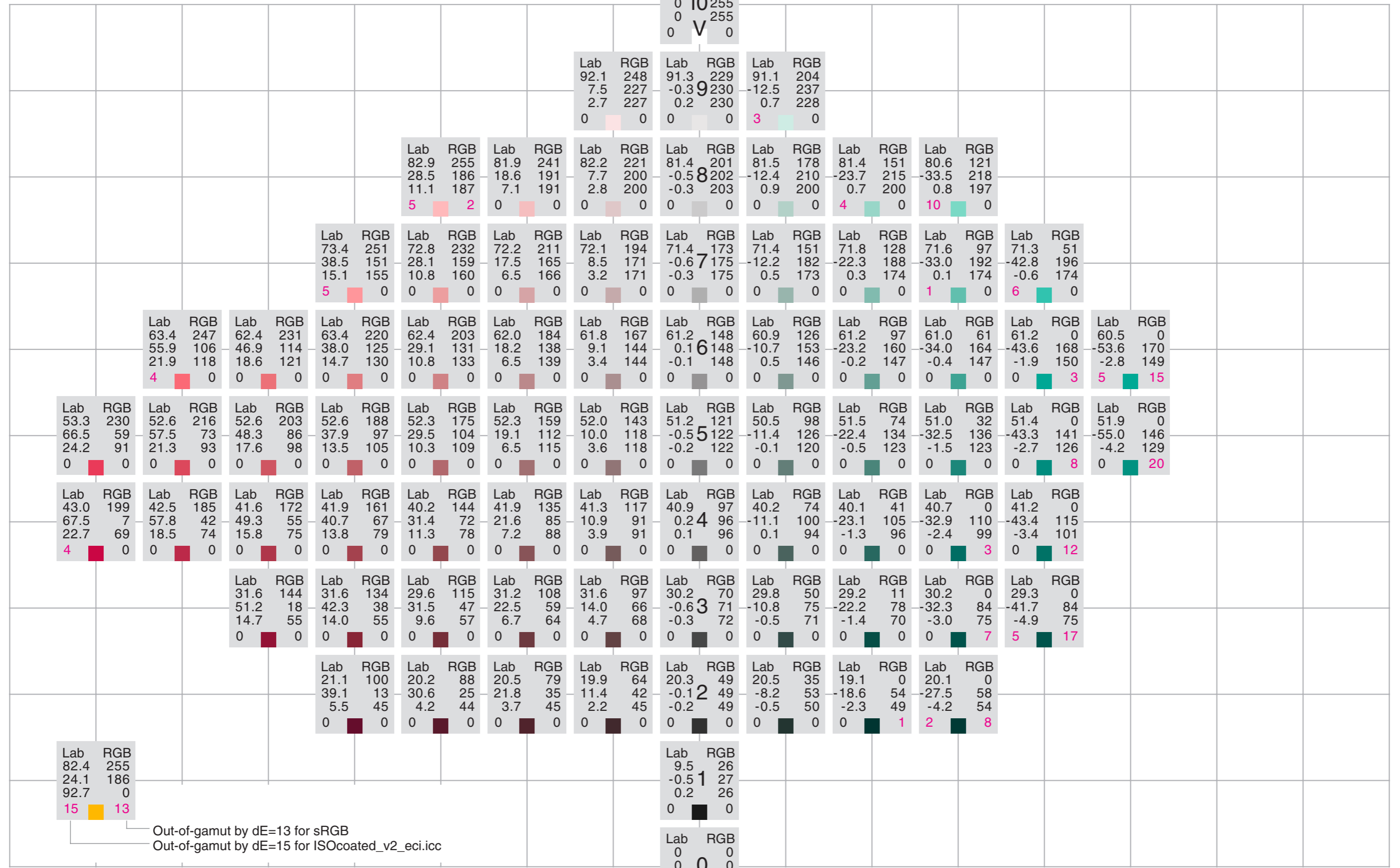
351° 2.5R

2.5BG 171°



351° 2.5R

2.5BG 171°



Out-of-gamut by dE=13 for sRGB
 Out-of-gamut by dE=15 for ISOcoated_v2_eci.icc

16 C 14 12 10 8 6 4 2 2 4 6 8 10 12 14 C 16

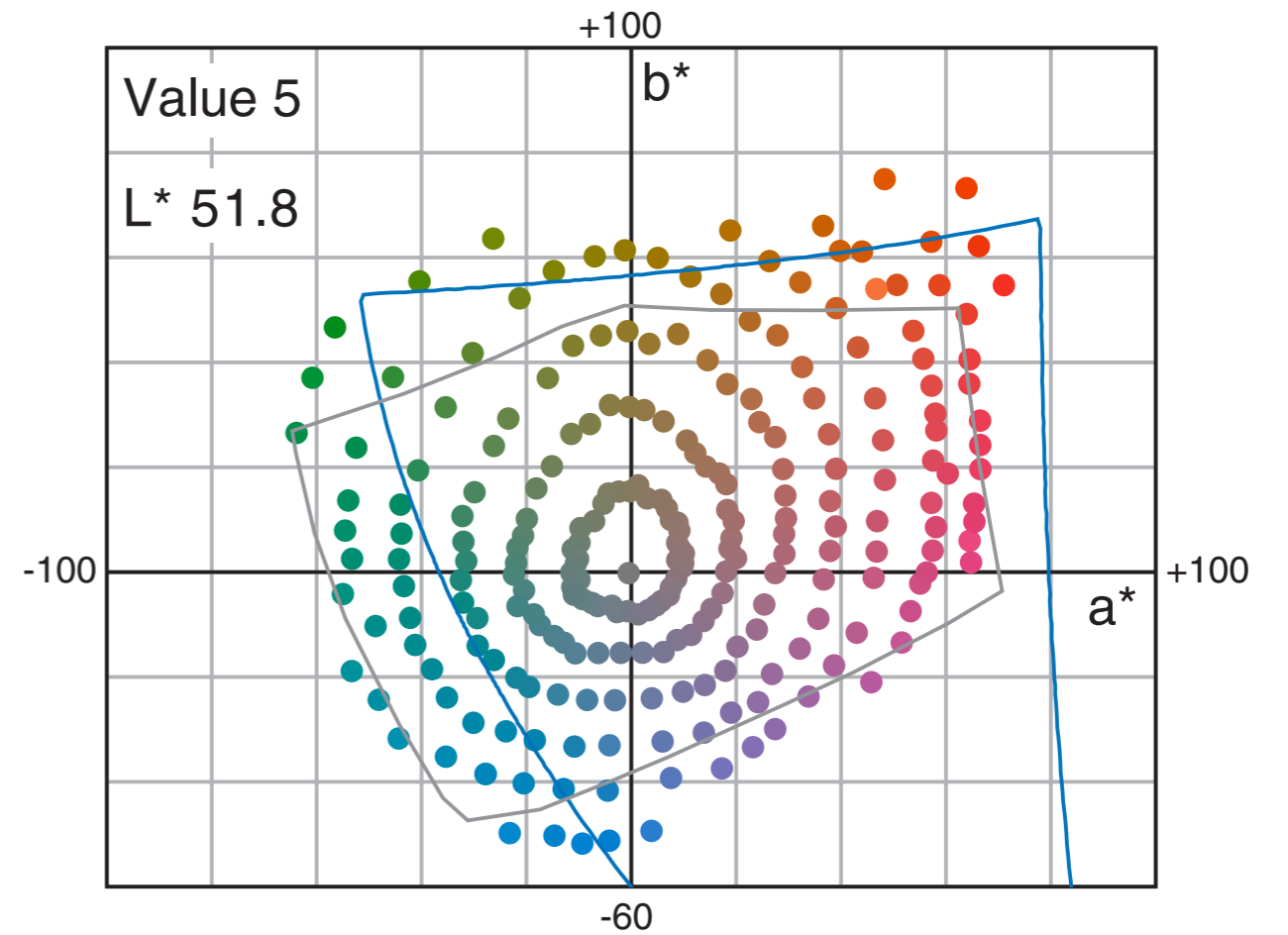
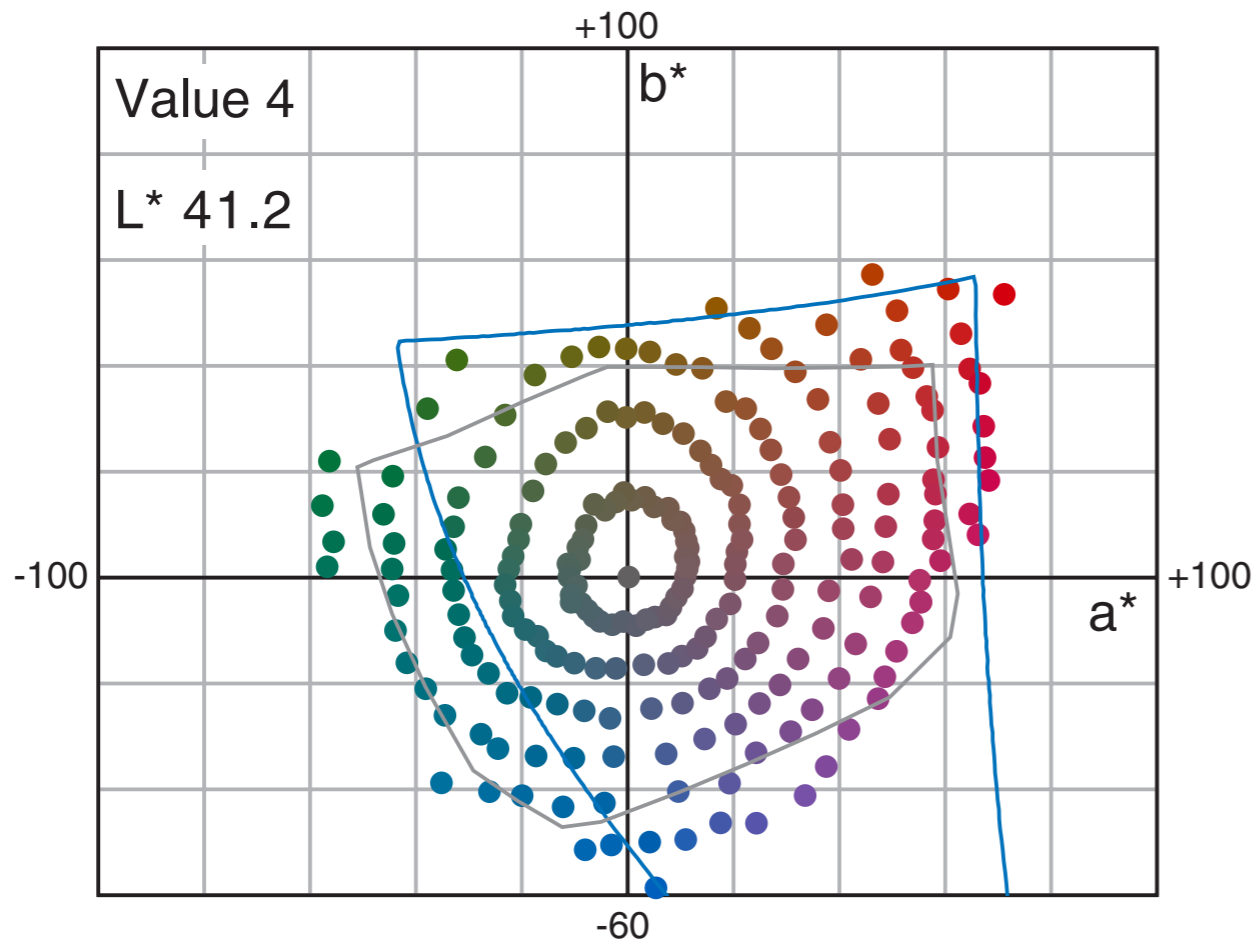
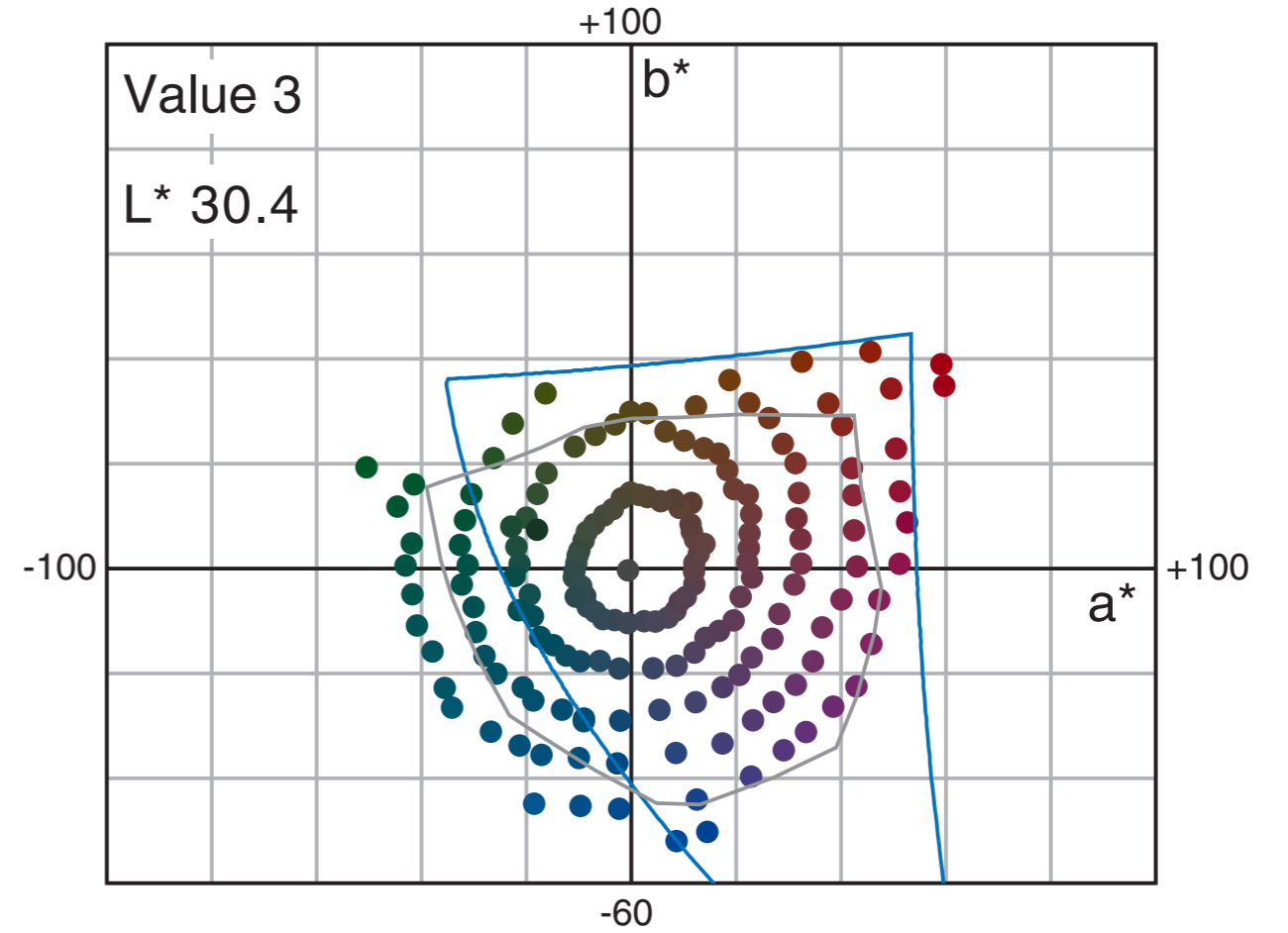
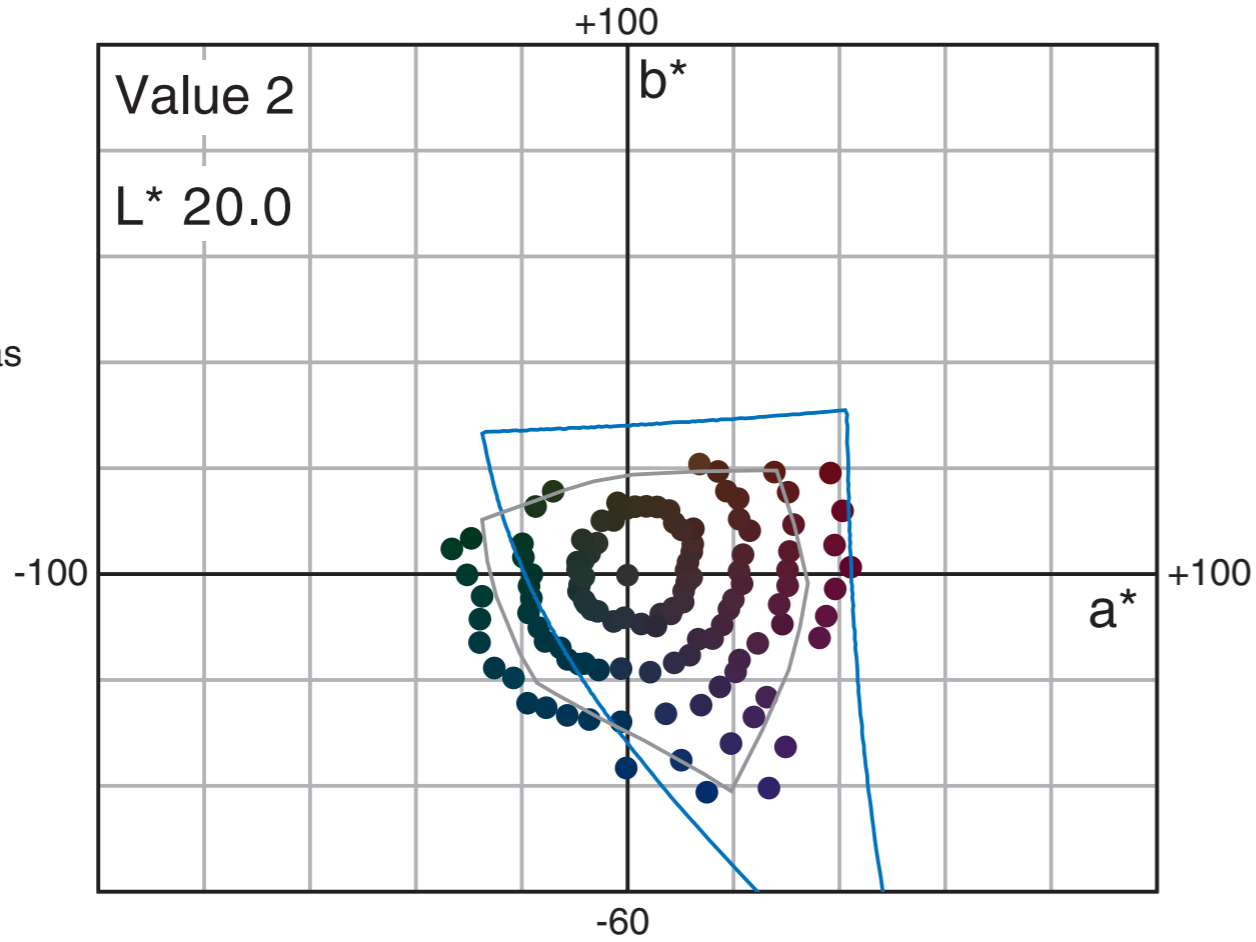
Planes of constant Value in CIELab

Gamut boundaries

Blue
sRGB

Gray
ISOCoated_v2_eci

L* was calculated as
mean value



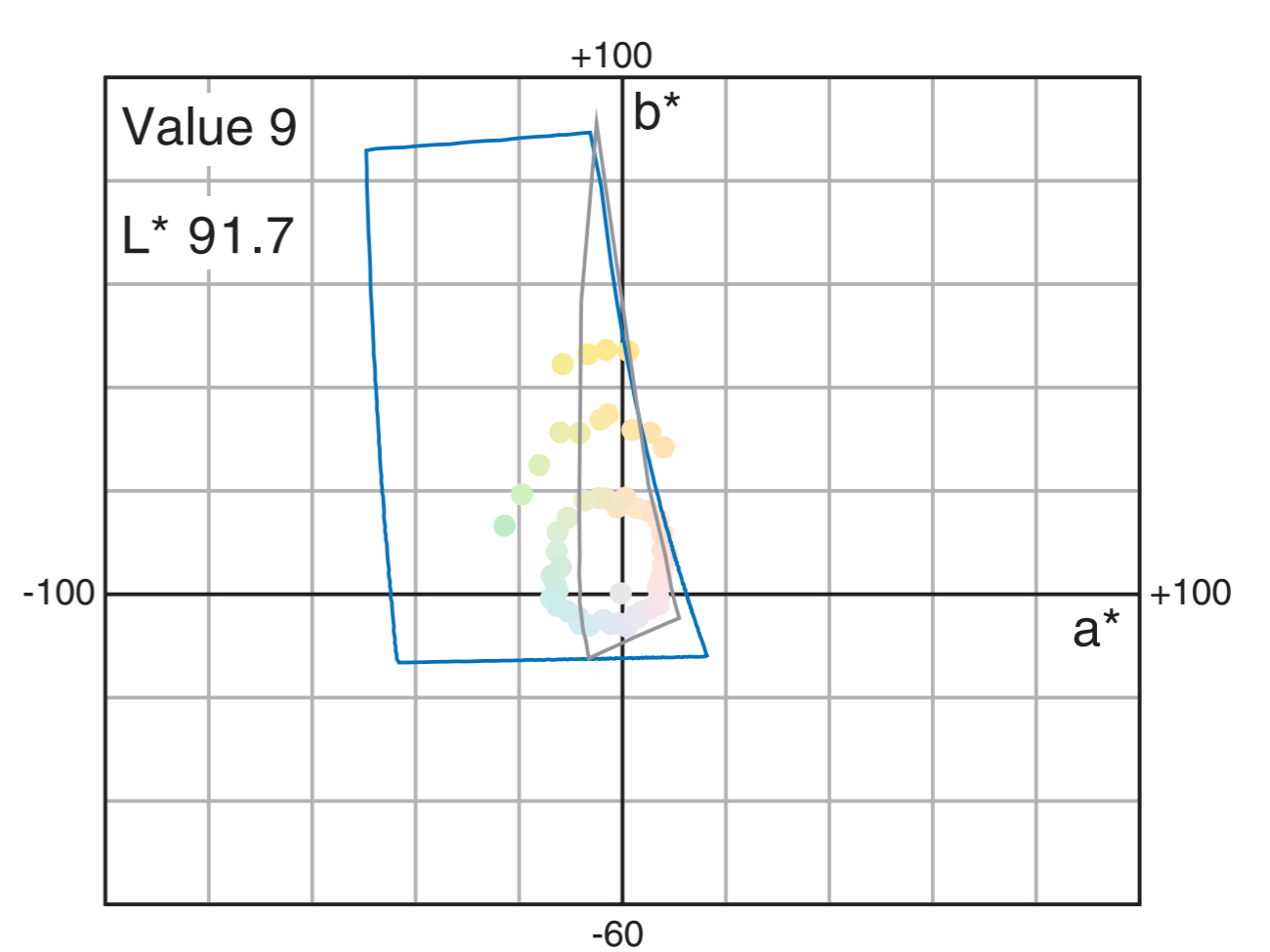
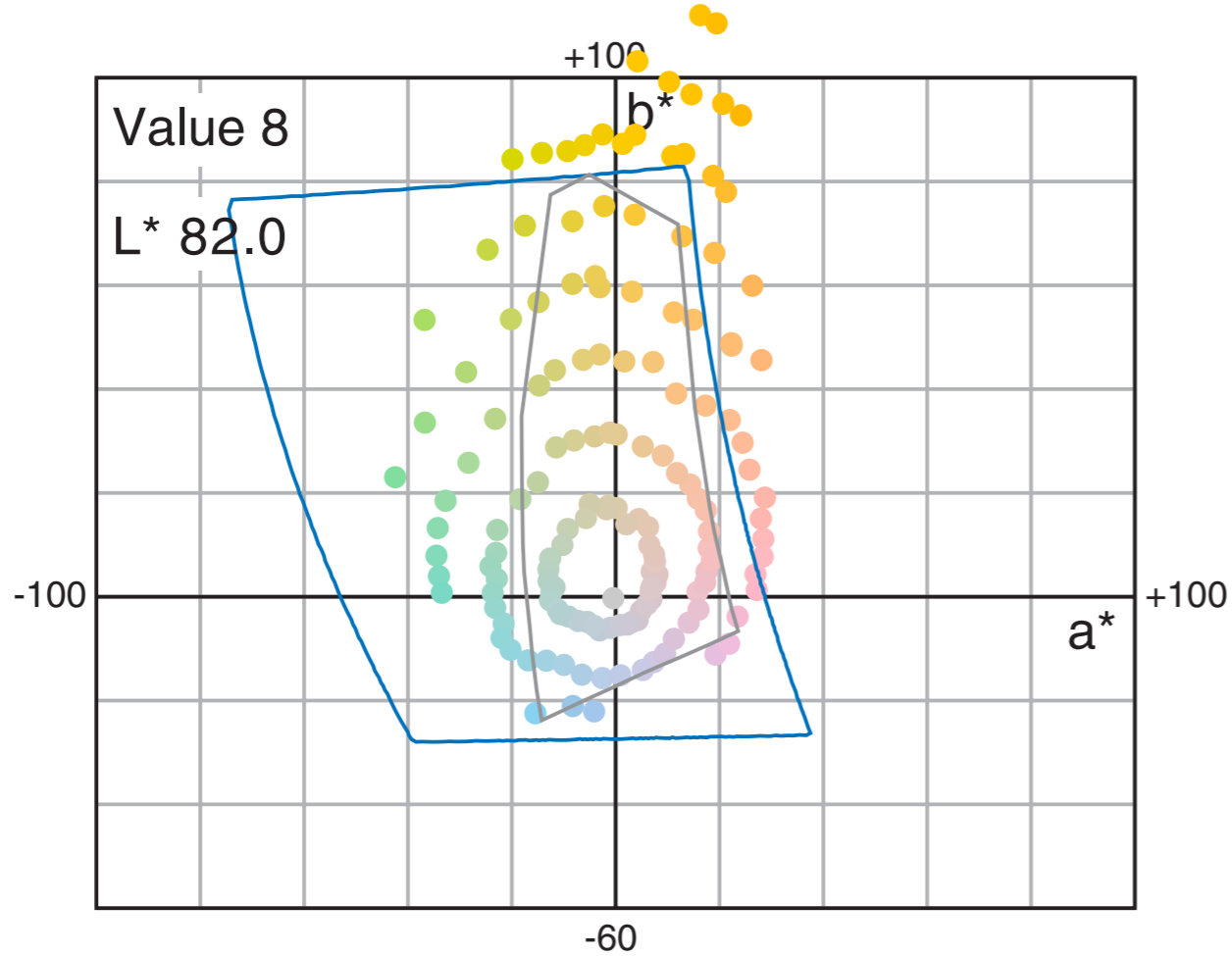
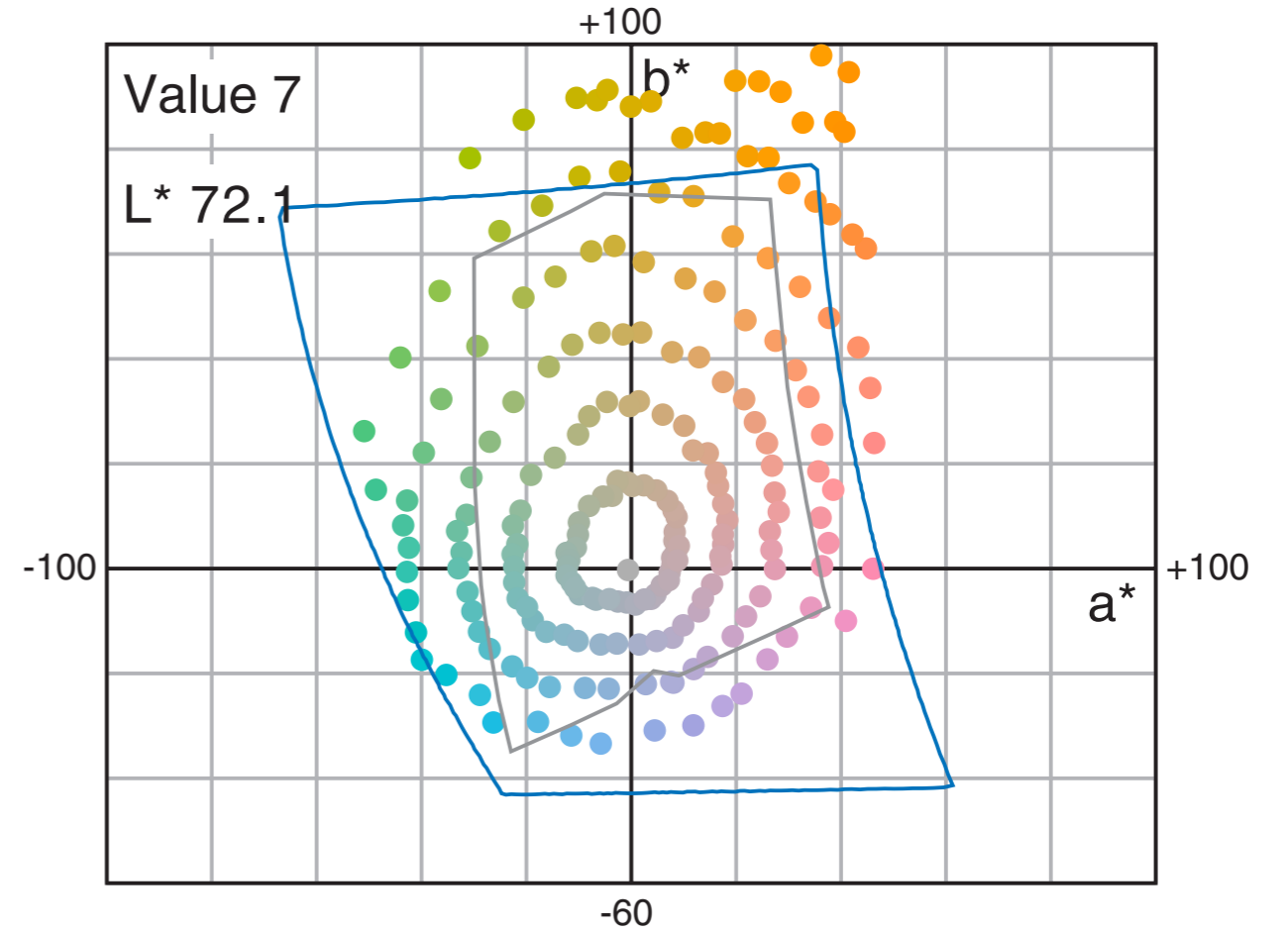
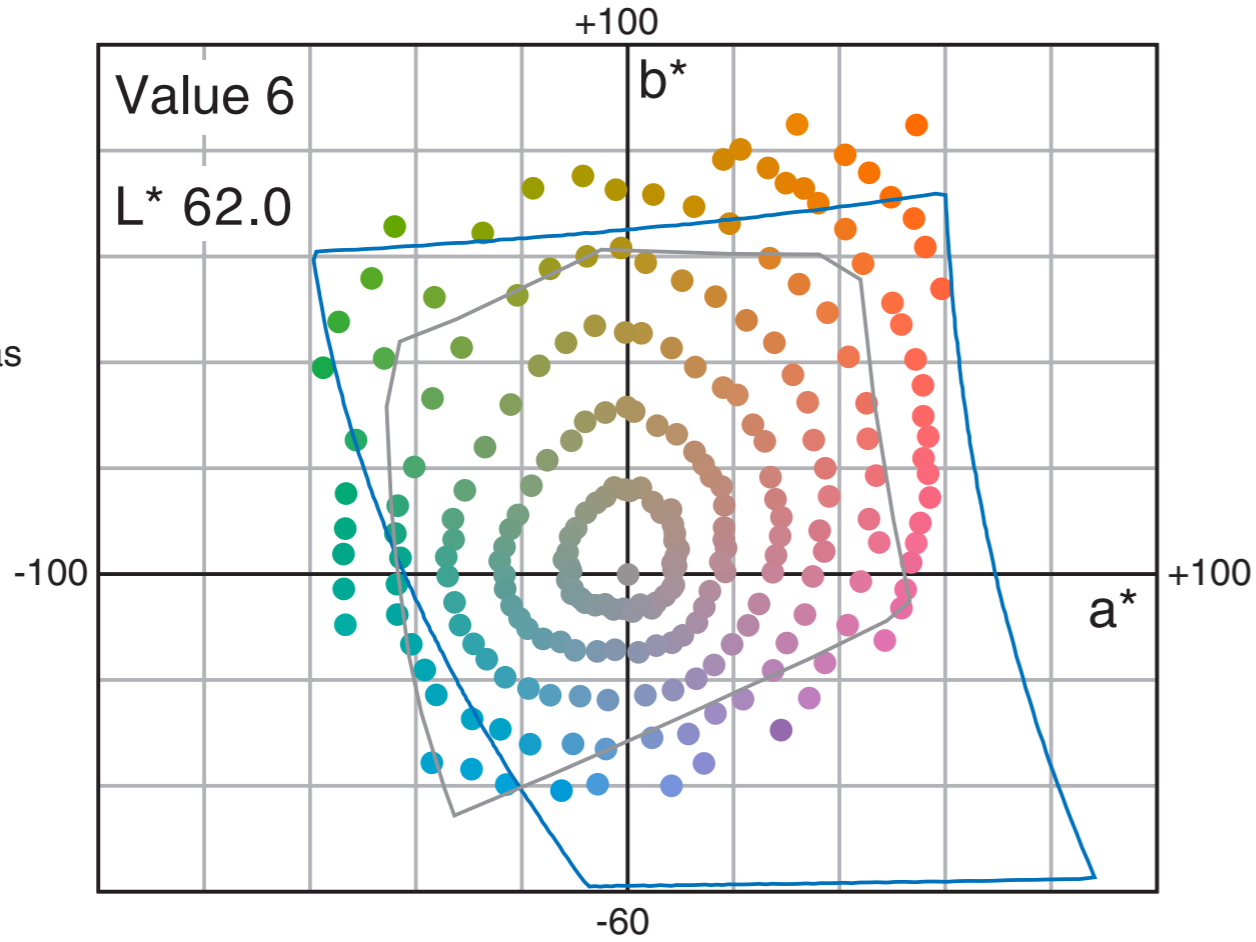
Planes of constant Value in CIELab

Gamut boundaries

Blue
sRGB

Gray
ISOCoated_v2_eci

L* was calculated as
mean value



References CIELab Document / Color patches and gray center-patches are defined by CIELab. Structuring elements and text are defined by K-only.

- [1] G.Wyszecki + W.S.Stiles
Color Science
John Wiley & Sons, New York ,..., 1982
 - [2] R.W.G.Hunt
Measuring Colour
Fountain Press, England, 1998
 - [3] R.W.G.Hunt
The Reproduction of Colour, Sixth edition
John Wiley & Sons, Chichester, 2004
 - [4] E.J.Giorgianni + Th.E.Madden
Digital Color Management
Addison-Wesley, Reading Massachusetts ,..., 1998
 - [5] R.S.Berns
Billmeyer and Saltzman's Principles of Color Technology, Third edition
John Wiley & Sons, New York ,..., 2000
 - [6] M.D.Fairchild
Color Appearance Models, Second Edition
John Wiley & Sons, Chichester, 2005
 - [7] H.R.Kang
Computational Color Technology
SPIE Press, Bellingham, 2006
 - [8] J.Morovič
Color Gamut Mapping
John Wiley & Sons, Ltd, Chichester, 2008
 - [9] J.D.Foley + A.van Dam + St.K.Feiner + J.F.Hughes
Computer Graphics
Addison-Wesley, Reading Massachusetts, ..., 1993
 - [10] C.H.Chen + L.F.Pau + P.S.P.Wang
Handbook of Pattern recognition and Computer Vision
World Scientific, Singapore, ..., 1995
 - [11] M.Stokes + M.Anderson + S.Chandrasekar + R.Motta
A Standard Default Color Space for the Internet - sRGB
<http://www.w3.org/graphics/color/sRGB.html>
1996
 - [12] M.Nielsen + M.Stokes
The Creation of the sRGB ICC Profile
Year unknown, after 1998
<http://www.srgb.com/c55.pdf> (dead link)
Search by title or use this link
<http://tinyurl.com/d7kwym>
 - [13] International Color Consortium
<http://www.color.org>
 - [14] Specification ICC.1:2004-10
http://www.color.org/icc_specs2.xalter
 - [15] European Color Initiative: Offset profiles
<http://www.eci.org/doku.php?id=en:start>
 - [16] ICC Profile Inspector
<http://www.color.org/profileinspector.xalter>
 - [17] Adobe System's Implementation of Black Point Compensation
<http://www.color.org/AdobeBPC.pdf>
 - [18] Munsell Color Science Laboratory
<http://www.cis.rit.edu/mcsl/online/munsell.php>
 - [19] Adobe Systems: The Munsell Color System
<http://web.archive.org/web/20030813092028/www.adobe.com/support/techguides/color/colormodels/munsell.html>
Use short URL:
<http://tinyurl.com/dg9ixx>
 - [20] G.Hoffmann
CIE (1931) Color Space
<http://docs-hoffmann.de/ciexyz29082000.pdf>
 - [21] G.Hoffmann
CIELab Color Space
<http://docs-hoffmann.de/cielab03022003.pdf>
 - [22] G.Hoffmann
Sphere Tessellation by Icosahedron Subdivision
<http://docs-hoffmann.de/ikos27042002.pdf>
 - [23] G.Hoffmann
Color Management by ICC Profiles
<http://docs-hoffmann.de/cmsicc08102003.pdf>
 - [24] G.Hoffmann
Gamut Visualizations and Out-of-gamut Distances
<http://docs-hoffmann.de/gamshow15052009.pdf>
 - [25] G.Hoffmann
PostScript Tutor
<http://docs-hoffmann.de/pstutor22112002.pdf>
 - [26] G.Hoffmann
Spot Swatch Book
<http://docs-hoffmann.de/swatch16032005.pdf>
 - [27] G.Hoffmann
Spectra for Proofing Light
<http://docs-hoffmann.de/prooflight18092003.pdf>
 - [28] Everything about Color and Computers
<http://www.efg2.com>
 - [29] X-Rite Munsell products
http://www.xrite.co.uk/top_munsell.aspx
 - [30] X-Rite ColorMunki
<http://www.colormunki.com/munsell>
- This doc:
<http://docs-hoffmann.de/munsell15052009.pdf>